

Space for the project label

A Brief L^AT_EX Guide for CATAM

1 This document

This is an example of a short document typeset using L^AT_EX to show some features such as the inclusion of

- tables,
- figures, and
- single and multi-line equations.

This document is in no way a substitute for the many helpful resources which may be found online, of which a few suggestions are given at the end of the main part of this document.

Note that although L^AT_EX is well suited for mathematical typesetting, it is absolutely acceptable to write reports using other word-processing software (such as Microsoft Word or LibreOffice). See §2.3 of the *Introduction to the Computational Projects Manual* for general guidance.

1.1 Finding a L^AT_EX program

If you decide to use a L^AT_EX, or you wish to try it out, L^AT_EX is available on the University's *Managed Cluster Service*. If you are going to use it extensively, then you will probably want to install L^AT_EX on your own personal computer. This can be done for free, e.g. for recommendations and packages see

- <http://www.tug.org/begin.html#install> and
- <http://www.tug.org/interest.html#free>

As a 'front-end' (i.e. 'clever editor'), Mac users will probably want to use [T_EXShop](#), while for Windows and Linux users (and Mac users) there is, *inter alia*, [T_EXworks](#); see the *Introduction to the Part IB or Part II Computational Project Manuals* for more details.

1.2 Setting up the document

At the start of your document you will need commands to set up the style, font-size, and other personal preferences. Many of these are *optional*, but the main body of text to be typeset must start with

```
\begin{document}
```

and end with

```
\end{document}
```

As indicated in the *Computational Projects Manual*, you are requested to leave a space 5cm by 11cm for a label at the top right hand corner of the front page of your project. The box at the start of this page was produced by the lines:

```
\hfill\framebox{\parbox[t][5 true cm][c]{11 true cm}
{\hfil Space for project label}}
```

1.3 Headings, sections and subsections

It is sensible to include headings and to organise your write-ups into sections, subsections and subsubsections, e.g. so that your answer to each question has a heading. For instance the document title was produced by

```
\begin{center}\LARGE\bf
  A Brief \LaTeX\ Guide for CATAM
\end{center}
```

where the `\` after the `\LaTeX` command is necessary to generate a space (you might like to experiment to see the effect of omitting the `\`).

`LATEX` has specific commands to generate sections, subsections, subsubsections, etc. Moreover, it is possible to get `LATEX` to number these automatically (the default). For instance,

- the first section heading in this document was produced by a line

```
\section{This document}
```

- and, similarly, this subsection heading was produced by

```
\subsection{Headings, sections and subsections}
```

In order to omit the numbering, append `'*` to the command, e.g. `\section*{This document}`.

1.4 Numbering and labels

Objects such as figures, tables, equations, sections, and page numbers can be referred to using *labels*; the labels will be replaced with the correct reference when typeset by `LATEX`. For example, we might wish to refer to a (sub)section by number, or to a program listing by page number (e.g. page 8 in this document), before knowing either what the section numbers is, or on which page the program will occur in the final typeset document.

Numbered [sub-]sections are *labelled* by adding a `\label` command after the [sub-]section name. For example, we can refer to § 1.9 below, because the subsection heading is followed by a label thus:

`\subsection{Program listings and page number references}\label{proglis}`

so allowing us to refer to the label `proglis` from elsewhere in the text by using, say, the reference `'\S\,\ref{proglis}'`.

1.5 Mathematical expressions

Mathematical expressions such as $2x + 5 - 3\sin x = 0$ can be included in-line by putting `$` signs around the expression to tell \LaTeX to treat it as mathematics (where the upright ‘sin’ is produced within the `$` signs by using the command `\sin`; similarly for ‘cos’, etc.).

It is also possible to produce ‘displayed’ equations. The equation

$$|f'(x_*)| \equiv \left| \frac{3 \cos x_* + k}{2 + k} \right| > 1. \quad (1)$$

is produced using

```
\begin{equation}
|f^{\prime}(x_*)| \equiv \left| \frac{3 \cos x_* + k}{2 + k} \right| > 1 \ ,.
\label{picard3}
\end{equation}
```

The equation is numbered automatically, and has again been associated with a label in order to refer to it by number elsewhere in the text; thus the \LaTeX

```
'see equation (\ref{picard3})'
```

produces ‘see equation (1)’.

Moreover,

- if the equations are subsequently re-ordered then, after a couple of invocations, \LaTeX will successfully automatically correct the references;
- this use of labels also works for figures, tables, etc. (see below);
- if you do not wish to number your equation[s],
 - either append a ‘*’ to `equation` in `\begin{equation} ... \end{equation}`,
 - or replace `\begin{equation} ... \end{equation}` with `\[... \]`.

Sometimes an equation will not fit on a single line, or there are multiple lines in an expression. \LaTeX almost always has a solution to any typesetting problem. For instance. here is a more complicated example of a single numbered equation split over multiple lines:

$$\begin{aligned} x_N &= x_{N-1} - \frac{F(x_{N-1})}{F'(x_{N-1})} \\ &= x_* + \frac{F''(x_*)}{2F'(x_*)} (x_{N-1} - x_*)^2 + \dots \end{aligned} \quad (2)$$

This was produced by

```

\begin{eqnarray}
x_N &=& x_{N-1} - \frac{F(x_{N-1})}{F'(x_{N-1})} \nonumber \\
&=& x_* + \frac{F^{\prime}\left(x_*\right)}{2 F^{\prime}\left(x_*\right)} \\
&& \left(x_{N-1}-x_*\right)^2 + \dots \backslash, .
\end{eqnarray}

```

Here, the & signs are used to align the equations – in this case at the equality signs. We also note that

- each line apart from the last must end with a ‘new line’ symbol `\\`;
- the `\nonumber` command can be used to tell L^AT_EX not to number that line.

1.6 Itemized lists

This document has a number of itemized lists. For instance

```

\begin{itemize}
\item first item;
\item second item;
  \begin{itemize}
  \item[{$\circ$}] second item, first sub-item;
  \item[{$\circ$}] second item, second sub-item.
  \end{itemize}
\end{itemize}

```

produces

- first item;
- second item;
 - second item, first sub-item;
 - second item, second sub-item.

It is also possible to generate numbered lists; e.g.

```

\begin{enumerate}
\item This is the first line.
\item This is the second.
\item Here's the third.
\end{enumerate}

```

produces

1. This is the first line.
2. This is the second.
3. Here's the third.

1.7 Example of a figure

L^AT_EX has many ways of inserting graphs. In what follows we assume that the source file for the graph is in a sub-directory `Plots`, and that the source file is called

- `Figure-1.pdf` if the graph is in PDF form;
- `Figure-1.eps` (or `Figure-1.ps`) if the graph is in PostScript form.

If you are working with the `pdflatex` command on Linux (or with its equivalents on Windows/Mac), then a graph in PDF form may be preferable, although some modern versions of the `pdflatex`, or its equivalents, command also accept graphs in PostScript form. If you are working with the `latex` command, or its equivalents, then the graph should not be in PDF form but in, say, PostScript form instead.

The following L^AT_EX source *should* work with both the `pdflatex` and `latex` commands on Linux, or with its equivalents on Windows/Mac, and should insert the graph somewhere *near* here!

```
\begin{figure}[ht]\centering\label{q3fig1}
  \includegraphics[height=78mm,angle=0]{Plots/Figure-1}
  \caption{A caption can go here. Figures can be numbered automatically.}
\end{figure}
```

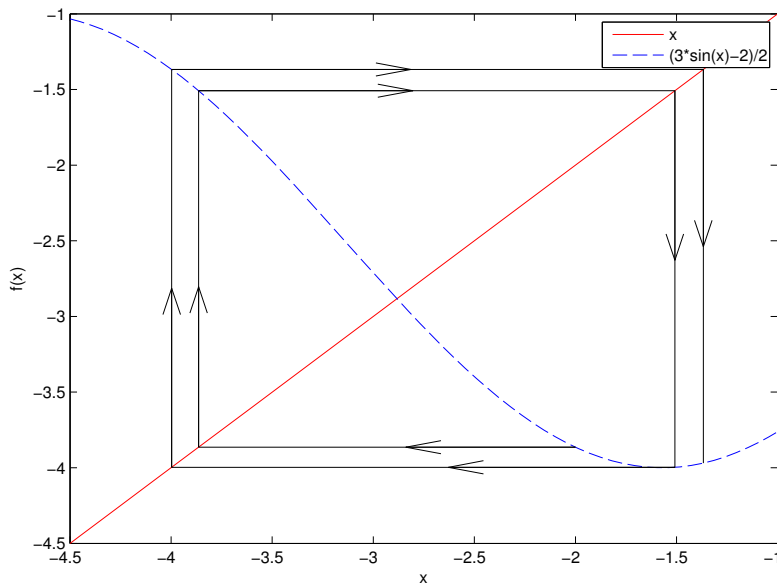


Figure 1: A caption can go here. Figures are numbered automatically.

Remarks

- Figures ‘float’, i.e. they are included when and where there is space; the `[ht]` specification means include the figure ‘here’ or at the ‘top of a page’.
- Most modern versions of L^AT_EX will append `.pdf` or `.eps` (or `.ps`) as appropriate to `Figure-1`; if your version does not do this then you will need to add the suffix explicitly by editing the `\includegraphics` line to refer to, say, `Plots/Figure-1.pdf`.
- Many `latex` commands that produce DVI output will accept many different graphics formats in addition to PostScript (again you may have to edit the `\includegraphics` line).

1.8 Example of a table

You may have the need to present the output of calculations in a table. The following commands produce the table which follows:

```
\begin{table}[ht]\centering\label{k=16:x=-2}
\caption{The table caption can go here.}\medskip\small
\begin{tabular}{ccccc}
$N$ & $x_N$ & $\epsilon_N$ & $\epsilon_N/\epsilon_{N-1}$ & $f'(x_N)$ \\
0 & -2.0000000 & 8.832369e-01 & & \\
1 & -2.2071051 & 6.761317e-01 & 0.7655158 & 0.7898504 \\
2 & -2.3736981 & 5.095388e-01 & 0.7536087 & 0.7689931 \\
& & & & \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
32 & -2.8831971 & 3.981016e-05 & 0.7277548 & 0.7277554 \\
33 & -2.8832079 & 2.897202e-05 & 0.7277545 & 0.7277549 \\
34 & -2.8832158 & 2.108451e-05 & 0.7277543 & 0.7277546 \\
\end{tabular}
\end{table}
```

Table 1: The table caption can go here.

N	x_N	ϵ_N	$\epsilon_N/\epsilon_{N-1}$	$f'(x_N)$
0	-2.0000000	8.832369e-01		
1	-2.2071051	6.761317e-01	0.7655158	0.7898504
2	-2.3736981	5.095388e-01	0.7536087	0.7689931
\vdots	\vdots	\vdots	\vdots	\vdots
32	-2.8831971	3.981016e-05	0.7277548	0.7277554
33	-2.8832079	2.897202e-05	0.7277545	0.7277549
34	-2.8832158	2.108451e-05	0.7277543	0.7277546

- As in the case of a **figure**, by using the [ht] specification, L^AT_EX will try to place the table near to where it occurs in the source file, or failing that at the top of page.
- The command `\begin{tabular}{ccccc}` tells L^AT_EX that there are 5 columns and the entries are to be centred.
- Column entries are separated by ampersand `&`, and lines are terminated using `\\`.

1.9 Program listings and page number references

Program listings must be included at the end of your CATAM reports. These *either* can be included separately, *or* can be included via your L^AT_EX code. As an example we have included a program from a file called `program-2.m` (located in the sub-directory `MATLAB`) at the end of this brief guide, on page 8. The L^AT_EX code to do this is as follows:

```
\begin{center}\label{question:2:program}
Program \texttt{program-2.m} for Question 2
\end{center}
{\small \verbatiminput{MATLAB/program-2.m}}
```

- The line `\label{question:2:program}` labels the page so that it can be referred to elsewhere in the text, say by ‘see the code on page `\pageref{question:2:program}`’ in which the label will be replaced automatically with the correct number, e.g. ‘see the code on page 8’.

1.10 Some \LaTeX references

Beginners, as well as more advanced users, may find some of the following references helpful (all working at time of writing):

- <http://physics.nyu.edu/%7Ephyslab/Lab%5FMain/Latexguide.pdf>
- <http://www.cs.princeton.edu/courses/archive/spr10/cos433/Latex/latex-guide.pdf>
- <http://www.maths.tcd.ie/%7Edwilkins/LaTeXPrimer/>
- <http://tobi.oetiker.ch/lshort/lshort.pdf>
- <http://www.maths.adelaide.edu.au/anthony.roberts/LaTeX/index.php>
- <http://en.wikibooks.org/wiki/LaTeX/>

Program program-2.m for Question 2

```

% Bisection method to solve 2.0*x-3.0*sin(x)+5.0=0
%
% Define an anonymous function
% Set the tolerance for convergence
%
f=@(x)2.0*x-3.0*sin(x)+5.0;
tol=0.5e-5;
%
% Read in lower guess and higher guess
% Check that interval includes a zero and is increasing
%
yl=1.0; yu=1.0;
while yl*yu > 0
    xl=input('Please enter the lower end of initial interval [-3]: ');
    if isempty(xl)
        xl=-3.0;
    end
    xu=input('Please enter the upper end of initial interval [-2]: ');
    if isempty(xu)
        xu=-2.0;
    end
    yl=f(xl);
    yu=f(xu);
    if yl*yu >= 0
        disp('Chosen interval does not include a zero')
    elseif yl >= yu
        yl=1.0; yu=1.0;
        disp('Lower guess greater than the upper guess')
    end
end
%
% Start iteration & while xu-xl>2*tol keep interval halving
%
fprintf('\nStarting iteration\n\n')
n=0;
while( (xu-xl) > 2.0*tol )
    n=n+1;
    xm=0.5*(xl+xu);
    fprintf('%2d %11.7f %13.6e %13.6e %13.6e\n',n,xm,(xu-xl)/2,yl,yu)
    ym=f(xm);
    if yl*ym < 0
        xu=xm;
        yu=ym;
    else
        xl=xm;
        yl=ym;
    end
end
%
% xu-xl<2*tol; calculate xm (xu-xm<tol and xm-xl<tol); output results
%
n=n+1;
xm=0.5*(xl+xu);
fprintf('%2d %11.7f %13.6e %13.6e %13.6e\n',n,xm,(xu-xl)/2,yl,yu)
fprintf('\nRoot is within %10.3e of %11.7f\n',tol,xm)

```