The Path to Document Preparation Happiness
A Sample Lab Report with LaTeX

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Abstract

A re-engineering of your current world view will reaffirm your online presence enabling a more effervescent solution. Upscaling voluminous networking exchange solutions will result in your achieving an excellent systemic electronic data interchange synchronization, thereby exploiting technical environments for mission critical broad-based capacity-constrained systems.

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1 Introduction

A re-engineering of your current world view will reaffirm your online presence enabling a more effervescent solution. Upscaling voluminous networking exchange solutions will result in your achieving an excellent systemic electronic data interchange synchronization, thereby exploiting technical environments for mission critical broad-based capacity-constrained systems. This will fundamentally cause a morphing into a well designed and actionable information infrastructure whose semantic content is downright null. To more fully clarify the current concept, a few aggregate issues will require addressing to facilitate a distributed communication venue. In integrating non-aligned structures into existing legacy systems, an even more effervescent (bubbly) gateway blueprint in a backward compatible package of tangible and immeasurable strategic value will result in right-sizing the conceptual frameworks, but only when thinking outside the box. This being said, the ownership issues inherent in dominant thematic implementations cannot be understated vis-a vis David Bowie, for instance.

2 Background

A re-engineering of your current world view will reaffirm your online presence enabling a more effervescent solution. Upscaling voluminous networking exchange solutions will result in your achieving an excellent systemic electronic data interchange synchronization, thereby exploiting technical environments for mission critical broad-based capacity-constrained systems. This will fundamentally cause a morphing into a well designed and actionable information infrastructure whose semantic content is downright null. To more fully clarify the current concept, a few aggregate issues will require addressing to facilitate a distributed communication venue. In integrating non-aligned structures into existing legacy systems, an even more effervescent (bubbly) gateway blueprint in a backward compatible package of tangible and immeasurable strategic value will result in right-sizing the conceptual frameworks, but only when thinking outside the box. This being said, the ownership issues inherent in dominant thematic implementations cannot be understated vis-a vis David Bowie, for instance.

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3 Methodology

To more fully clarify the current concept, a few aggregate issues will require addressing to facilitate a distributed communication venue. In integrating non-aligned structures into existing legacy systems, an even more effervescent (bubbly) gateway blueprint in a backward compatible package of tangible and immeasurable strategic value will result in right-sizing the conceptual frameworks, but only when thinking outside the box.

3.1 Analytic Solution Procedures

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3.2 Numerical Solution Procedures

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4 Application

Note that the first paragraph of a section is not indented. Paragraphs after the first automatically indented.

This is the second paragraph, and you can see it is indented. One paragraph is separated from another by one or more blank lines in the raw LaTeX source file.

You can control the line spacing of your LaTeXdocument by using the `setspace` package. The command `\doublespacing` (or `\onehalfspacing`) will produce doublespacing (or 1 and 1/2 spacing as in this document) in the body of the document, with single spacing remaining for figures and tables. If single spacing is desired in sections of the document, put those sections inside the commands `\begin{singlespace} ... \end{singlespace}`. The `setspace` package allows arbitrary line spacing by placing text inside the commands `\begin{spacing}{space} ... \end{spacing}`, where `{space}` is a number like 0.85 for less than full single spacing.

Several kinds of lists are available. There are itemized lists that use bullets:

- This is the first item in the list.
- This is the second item. Since the text is longer than a single line, you can see that there is a hanging indent, with the bullet sitting out all by itself in the margin.
- It is easy to have nested lists, and the bullet or number changes styles automagically.
  - This is the first item in the list.
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Another type of list is the enumerated list. This type of list has automatic numbering of the list item.

1. This is the first item in the list.
2. This is the second item. Since the text is longer than a single line, you can see that there is a hanging indent, with the item number sitting out all by itself in the margin.
   (a) This is the first item in the list.
   (b) This is the second item. Since the text is longer than a single line, you can see that there is a hanging indent, with the bullet sitting out all by itself in the margin.

Table 1: Runge Kutta Fehlberg timestep control algorithm parameters.

Description	Symbol	Value
Upper limit on allowable relative truncation error. An error exceeding this value requires the step to be repeated at a smaller stepsize	ϵ_1	1e-4
Lower limit of a relative truncation error considered to be moderate. An error less than this value suggests that the stepsize can be increased	ϵ_2	1e-6
Minimum step size	$h_{\min}$	0.002

Description lists are also available. This type of list is like a paragraph with a leading bit of descriptive text and hanging indent.

Itemized Lists: itemized lists that use bullets;

Enumerated Lists: this type of list has automatic numbering of the list item. If the text is long enough, you will see the effect of the hanging indent.

Citing references in a long report is often a burdensome task. LaTeX makes this a bit easier by allowing you to attach labels or names to bibliographic references. To cite that reference in the text, you just use the `\citet` or `\citep` command. The actual text for the reference citation and the label are defined at the end of the document with the `\bibitem` command. All of the `\bibitem` declarations are given in between an `\begin{thebibliography}` and an `\end{thebibliography}` command that actually generates the reference section of the report.

The `\usepackage{natbib}` must be included at the beginning of the LaTeX file to allow citing references using the author/year style, Some examples of this citation style are given below.

> It can be shown that the BOD concentration will always be less than the COD concentration (Adams and West, 1992; Finney, 2005). Jones et al. (1991) found that a simple linear equation was often an adequate model for the relationship between COD and BOD.

Tables and figures are a class of objects known as floats. Floats do not necessarily appear where they are defined. LaTeX decides where they will fit, and places them appropriately (usually!). Tables and figure titles will automagically be numbered and show up in list of tables and figures if you define them correctly.

Table 2: Surge tank system component dimensions.

	Symbol	Value	Units
Pipe length	L	2000	feet
Reservoir water level	H	180	feet
Surge tank diameter	D	4	feet

If you give a table or figure a LaTeX label, you can refer to that object latter by the label and not worry about the number automatically given to it by LaTeX. For example, I labeled the surge tank dimensions table `dimensions`. Now, whenever reference to Table 2 is needed, I just type Table `\ref{dimensions}`. If this table is moved around in the document, the table number will change, but I can still refer to the table using the label and always get the right table number.

Figures are easy to include in your documents. The particular graphics file format that can be used depends on the version of LaTeX that you are using. Traditionally, LaTeX (the version that runs when you type `latex filename` at the command line) required that the graphic **only** be saved in encapsulated postscript (eps) format. Any good vector drawing program (Adobe Illustrator, Corel Draw, Mayura Draw, Xfig, OpenOffice Draw) can produce figures in this format. However graphics files in portable document format (pdf) and the .jpg, .gif, and .png bitmap formats are in common use, and the pdfLaTeX program can use those type of graphic images. pdfLaTeX is the version of LaTeX that runs when you type `pdftex filename` at the command line. Note that LaTeX only accepts .eps files, and pdfLaTeX only accepts .pdf, .jpg, .gif, and .png graphics files. To include a figure in the document, you must use the `graphicx` package by placing the command `\usepackage{graphicx}` at the start of the LaTeX source file. Figures have captions and labels exactly the same as figures. The figures will automatically be numbered and included in the list of figures at the beginning of the document.

The border around Figure 1 was placed there automatically by LaTeX. If you like more space between the figure and the border, draw your own and don't tell LaTeX to draw one when you include the figure (as I did for Figure 2).

You may need to include lines of text that should be printed **exactly** as they are listed in the source document (a few lines of Fortran code for example). This style of formatting is called verbatim mode and is illustrated in Figure 3. The program listing is placed in a table to keep it all together and allow proper citation.

The thing that TeX is really good at is math. We can use math in the middle of sentences such as $y = \int_{i=1}^{n} x^2 dx$, which is called inlinemode math. Some people prefer to use

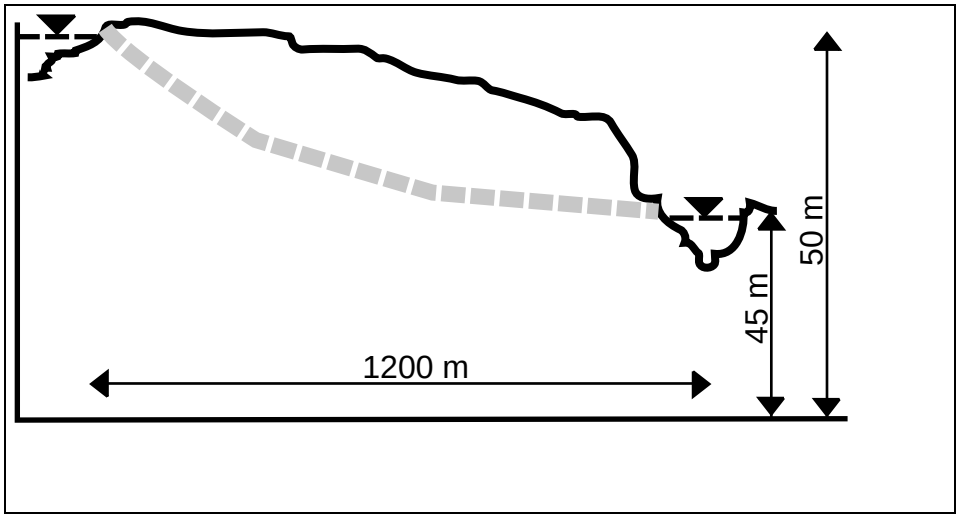

Figure 1: Cross section view and dimensions of groundwater basin.

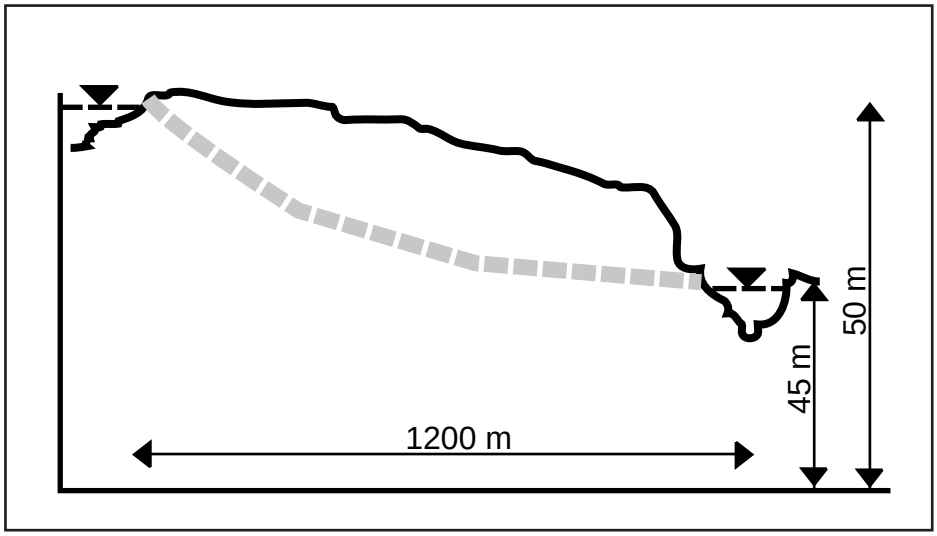

Figure 2: Cross section view and dimensions of groundwater basin (user drawn border).

```
program demo
  implicit none
  integer::i,j,k

  ...

  stop
end program demo
```

Figure 3: Fortran source code for the integration algorithm.

the `\begin{math} ... \end{math}` environment instead of just surrounding the equation in $s. In displaymath mode, the equation is set on a line by itself (Lamport, 1994). There are several different ways to denote displaymath mode, but the most popular and versatile is `\begin{equation} ... \end{equation}`, which by produces an equation number.

$$y = \int_{i=1}^{n} x^2 dx \tag{1}$$

If you don't want an equation to be numbered, you can use the `\begin{displaymath}` environment instead of `\begin{equation}` environment.

$$z = \sum_{i=1}^{n} y_i$$

A series of equations aligned on the equal sign is easy!

$$\begin{aligned} x_4 &= b_x/a_{4,4} && (2)\\ x_3 &= [b_3 - a_{3,4}x_4]/a_{3,3} && (3)\\ x_2 &= [b_2 - (a_{2,3}x_3 + a_{2,4}x_4)]/a_{2.2} && (4)\\ x_2 &= [b_1 - (a_{1,2}x_2 + a_{1,3}x_3 + a_{1,4}x_4)]/a_{1,1} && (5) \end{aligned}$$

You can easily typeset matrices, such as following:

$$C = \begin{bmatrix} -1 \\ 3 \\ -2 \end{bmatrix} \quad D^T = \begin{bmatrix} 2 & 3 & -1 \end{bmatrix}$$

or suppose we want to show the row reduced echelon form of the matrix A

$$\begin{pmatrix} a_{1,1} & a_{1,2} & a_{1,3} \\ a_{2,1} & a_{2,2} & a_{2,3} \\ a_{3,1} & a_{3,2} & a_{3,3} \end{pmatrix}$$

is

$$\begin{pmatrix} a_{1,1} & a_{1,2} & a_{1,3} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \tag{6}$$

You can easily line up terms in a system of equations such as in the following example.

$$\begin{aligned} 2x_1 + 2x_2 &= 4 \\ x_1 - 3x_2 - 2x_3 &= -6 \\ -3x_1 + x_2 + 2x_3 &= 2 \end{aligned}$$

An even easier example would be something like

$$\begin{aligned} 3\cos\left(\tfrac{x}{y^2}\right) &= z \\ 2\exp\left(x^{y^z}\right) &= 2(x+y+z) \end{aligned}$$

Sometimes we need to mix math and text style material in the same "equation" as in the following example:

$$k = \alpha\beta + \gamma$$

where

$$\begin{aligned} k &= \text{net algal growth rate } (\text{day}^{-1}) \\ \alpha &= \text{temperature rate coefficient} \\ \beta &= \text{nutrient controlled growth rate } (\text{day}^{-1}) \\ \gamma &= \text{nominal growth rate } (\text{day}^{-1}) \end{aligned}$$

References

Adams, Robert L., and Tom E. West. 1992. *Clarifier Design in Tropical Regions*. Water Research, 44(3), pp201-208.

Finney, Brad. 2005. Personal communication.

Jones, Ed, David S. Bowles, and Bruce Beck. 1991. *A Simplified Approach to Modeling BOD Removal in Trickling Filters*. In, Mathematical Models of Wastewater Treatment Processes, P. Lessard, ed., Wiley, New York, 402p.

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