Fachhochschule Kärnten
Carinthia University of Applied Sciences
Integrated Systems and Circuits Design

MASTER THESIS

A Template for Master Theses at the Carinthian University of Applied Sciences with a Short Introduction to Formulas and Figures

Submitted in Partial Fulfillment of the Requirements of the Academic Degree

Master of Science in Engineering, Msc

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Villach, June 2011

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Abstract

This thesis shortly describes how to generate formulas in LaTex (with and without numbering) and how to include figures into a LaTeX document.

Key words: LaTeX, Graphics, Formulas, Mathematics, Figures, References

Acknowledgement

I would like to thank my first supervisor ....

(Eventually a company logo can be included on this page)

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Chapter 1

Introduction

Note: The chapter 1.1 and 1.2 of this introduction are taken from the webpage

http://en.wikibooks.org/wiki/LaTeX/Introduction.

1.1 What is TEX?

TEX (X or chi is pronounced as in Scottish loch) is a low-level markup and programming language created by Donald Knuth to typeset documents attractively and consistently. Knuth started writing the TEX typesetting engine in 1977 to explore the potential of the digital printing equipment that was beginning to infiltrate the publishing industry at that time, especially in the hope that he could reverse the trend of deteriorating typographical quality that he saw affecting his own books and articles. TEX is a programming language, in the sense that it supports the if-else construct, you can make calculations with it (that are performed while compiling the document), etc., but you would find it very hard to make anything else but typesetting with it. The fine control TEX offers makes it very powerful, but also difficult and time-consuming to use. TEX is renowned for being extremely stable, for running on many different kinds of computers, and for being virtually bug free. Nowadays when producing documents in the TEX language, practically nobody uses plain TEX. Instead, different TEX distributions such as LATEX are used to save time, automate certain tasks and reduce user introduced errors.

1.2 What is LATEX?

LATEX (pronounced either "Lah-tech" or "Lay-tech") is a macro package based on TEX created by Leslie Lamport. Its purpose is to simplify TEX typesetting, especially for documents containing mathematical formulae. Many later authors have contributed extensions, called packages or styles, to LATEX. Some of these are bundled with most TEX/LATEX software distributions; more can be found in the Comprehensive TEX Archive Network (CTAN). Since LATEX comprises a group of TEX commands, LATEX document processing is essentially programming. You create a text file in LATEX markup. The LATEX macro reads this to produce the final document. This approach has some disadvantages in comparison with a WYSIWYG (What You See Is What You Get) program such as Openoffice.org Writer or Microsoft Word.

In LATEX

- You don't (usually) see the final version of the document when editing it.
- You generally need to know the necessary commands for LATEX markup.
- It can sometimes be difficult to obtain a certain look for the document.

On the other hand, there are certain advantages to the LATEX approach:

- Document sources can be read with any text editor and understood, unlike the complex binary and XML formats used with WYSIWYG programs.
- You can concentrate purely on the structure and contents of the document, not get caught up with superficial layout issues.
- You don't need to manually adjust fonts, text sizes, line heights nor text flow for readability, as LATEX takes care of them automatically.
- In LATEX the document stucture is visible to the user, and can be easily copied to another document. In WYSIWYG applications it is often not obvious how a certain formatting was produced, and it might be impossible to copy it directly for use in another document.
- The layout, fonts, tables and so on are consistent throughout the document.
- Mathematical formulae can be easily typeset.
- Indexes, footnotes, citations and references are generated easily.
- You are forced to structure your documents correctly.

The LATEX-like approach can be called WYSIWYM, i.e. What You See Is What You Mean: you can't see what the final version will look like while typing. Instead you see the logical structure of the document. LATEX takes care of the formatting for you. The LATEX document is a plain text file containing the content of the document, with additional markup. When the source file is processed by the macro package, it can produce documents in several formats. LATEX natively supports DVI and PDF, but by using other software you can easily create PostScript, PNG, JPG, etc.

Chapter 2

Help for a Quick Start

2.1 Lists

This chapter contains an overview about different lists in LaTeX.

2.1.1 The \itemize List

- This is a *itemize*-list
- The mark of depth level 1 is a thick black dot.
  - The mark of depth level 2 is a long dash.
    - A star is the mark of level 3.
      - Last depth level has a small dot.
      - As you can see the vertical distance gets smaller with increasing depth.
    - Back to level 3.
  - Back to level 2.
- And here is the first level again.

2.1.2 The \enumerate List

1. This is a *enumerate*-list
2. The numbering of the first level is in arabic numbers, followed by a dot.
   (a) The mark of depth level 2 are lower case letter in round brackets.
      i. Small roman letters followed by a dot are the marks of level 3.

        A. Last depth level has capital letters.
        B. A change in the style of the marks is possible and is demonstrated in chapter 2.1.3
      ii. Back to level 3.
   (b) Back to level 2.
3. And finally back to the first level.

2.1.3 A List, Where the Marks Change.

- This starts with a *itemize*-list and the mark is a thick black dot
  1. The mark of depth level 2 are arabic numbers, because this is the first level of the \enumerate list.
     – This is the third nested level but the second of the \itemize list and gets therefor a dash.
       (a) This is the last level of the list but the second level of the \enumerate list.
       (b) Therefor the numbering are lower case letter ind round brackets.
     – Back to level 3.
  2. Back to level 2.
- And finally back to the first level.

2.2 Mathematical Formulas

One of the greatest motivating forces for Donald Knuth when he began developing the original TeX system was to create something that allowed simple construction of mathematical formulas, whilst looking professional when printed. The fact that he succeeded was most probably why TeX (and later on, LaTeX) became so popular within the scientific community. Regardless of the history, typesetting mathematics is one of LaTeX's greatest strengths. It is also a large topic due to the existence of so much mathematical notation.

If you are writing a document that needs only a few simple mathematical formulas, then you can generally use plain LaTeX: it will give you most of the tools you need. However, if you are writing a scientific document that contains numerous complicated formulas, it is highly recommended that you use the amsmath or mathtools (which automatically includes amsmath) packages, which introduce several new commands that are more powerful and flexible than the ones provided by plain LaTeX. To use this, include:

$\backslash usepackage\{amsmath\}$ or

$\backslash usepackage\{mathtools\}$

in the preamble of the document.[1]

The following shows a few examples of formulas, starting with a simple and ending with a more advanced one.

1. Saturation Current in a MOS-Transistor
$$I_{DS} = \frac{1}{2}\mu C_{ox}\frac{W}{L}\left(V_{GS} - V_{TH}\right)^2 \tag{2.1}$$

2. μC_{ox} can be replaced by K so formula 2.1 can be also written as
$$I_{DS} = \frac{1}{2}K\frac{W}{L}\left(V_{GS} - V_{TH}\right)^2 \tag{2.2}$$

3. The next equation shows an example of an equation array. Note that the second line has no equation number!
$$\begin{aligned} g_m &= \frac{\partial I_{DS}}{\partial V_{GS}} \qquad (2.3) \\ &= \mu_n C_{ox}\frac{W}{L}\left(V_{GS} - V_{TH}\right) \\ &= \frac{2I_{DS}}{V_{GS} - V_{TH}} \qquad (2.4) \end{aligned}$$

4. Next example: Gauss' Law, Integral Form:
$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\varepsilon_0} \tag{2.5}$$

5. Here comes an example with subequations (e.g. Maxwell's equations):
$$B' = -\partial \times E, \tag{2.6a}$$
$$E' = \partial \times B - 4\pi j, \tag{2.6b}$$

6. The last example is a little bit more complicated. Note that this also contains the control sequence \T as abbreviation for \textstyle.
$$\alpha = \frac{1}{N-1}\sum_{k=1}^{N-1}\left(\frac{U_k}{I_k}\right)^{\frac{\sqrt{|U_{k+1}|}}{\sqrt{|U_k|}-\sqrt{|U_{k+1}|}}} \cdot \left(\frac{I_{k+1}}{U_{k+1}}\right)^{\frac{\sqrt{|U_k|}}{\sqrt{|U_k|}-\sqrt{|U_{k+1}|}}} \tag{2.7}$$

2.3 Tables

The following shows two examples of a table. Table 2.1 shows the most common display resolutions of display devices:

The table 2.2 show another way without vertical separating lines.

[1]Text taken from http:en.wikibooks.orgwikiLaTeXFormatting#Footnotes

Table 2.1: Display Resolutions of Common TV Standards

Code	Name	Aspect Ratio	Width	Height
VGA	Video Graphics Array	4 : 3	640	480
PAL	Phase Alternating Line	4 : 3	768	576
HD 720	Standard High Definition TV	16 : 9	1080	720
HD 1080	Full High Definition TV	16 : 9	1900	1080

Table 2.2: FastSPICE Evaluation 2007: PMU

FastSPICE Simulator	**Simulation Runtime**
Nanosim	30h
Finesim	33h
Ultrasim	not able to simulate design
XA	20h
Adit	47h

2.4 How to Include Graphics

Now lets try to include some graphics. There are two ways to incorporate images into your LaTeX document, and both use the graphicx package by means of putting the command \usepackage{graphicx} near the top of the LaTeX file, just after the documentclass command.

The two methods are

1. Include only PDF, PNG, JPEG and GIF images if your goal is a PDF document using pdflatex, TeXShop, or other PDF-oriented compiler.

2. Include only PostScript images (esp. “Encapsulated PostScript”) if your goal is a PostScript document using dvips (not recommended)

In all cases, each image must be in an individual 1-image file; no animation files or multipage documents are possible.

The compiler **pdflatex** converts LaTeX source directly to PDF, and does not accept PostScript images. Instead, they take PDF images, as well as bitmap pictures in PNG or JPEG or GIF format. So to use pdflatex, you must convert any PostScript images to one of these other forms. For photos, JPEG is best. For other bitmap images, PNG is best. For non-bitmap images (e.g., graphs, drawings, stuff with text and symbols) it is best to convert to PDF, using the command epstopdf (in the corresponding TeX bin directory). The command

epstopdf myfig.eps

produces the file myfig.pdf, which can for compilation with pdflatex subsequently be used in the command **\includegraphics{myfig.pdf}** .

Possible \includegraphics options with PDF/PNG/JPG images are e.g.

- \includegraphics{myfig.pdf}
  \includegraphics[scale=0.75]{myfig.pdf}
  - Example
    Figure 2.1: \includegraphics[scale=0.5]{./thd.pdf}

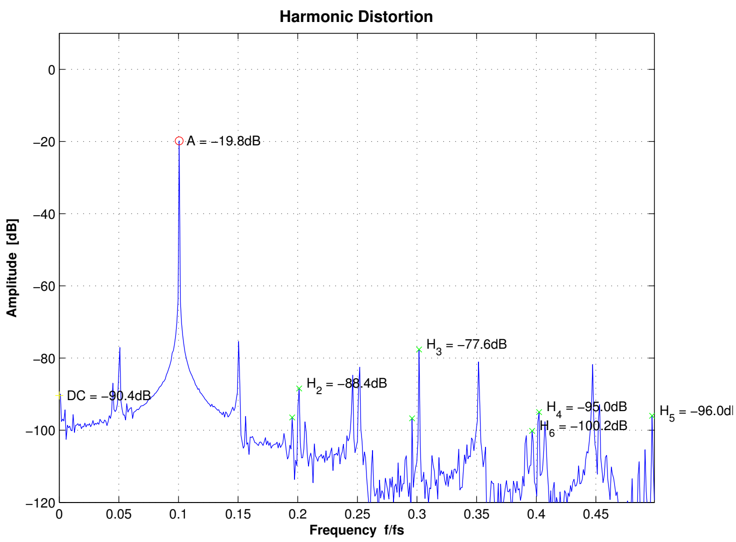

Figure 2.1: Total Harmonic Distortion

- \includegraphics[height=50mm]{myfig.png}
  - Examples:
    Figure 2.2: \includegraphics[height=25mm]./unix-plate.png
    Figure 2.3: \includegraphics[angle=45,width=0.30\textwidth]./unix-plate.png

- \includegraphics[width=50mm]./myfig.jpg
  - Example:
    Figure 2.4: \includegraphics[width=0.30\textwidth]./titanic-bow.jpg

Figure 2.2: Unix®License Plate

Figure 2.3: Unix®License Plate with angle

With PNG or JPEG you should specify an explicit width or height rather than scale, since bitmap images have no intrinsic size, nothing corresponding to Bounding Box information, although graphicx seems to use 72 pixels per inch as a default size for bitmap images.

It is also very easy to establish a reference to a picture. You simply have to place a label to the description of the picture and make a reference to that label. The figure 2.4 on page 9 for example shows the bow of the sunken Titanic.

2.5 Using Different Fonts

This section shows how to use different fonts:

Here we switch to Palatino font:

With PNG or JPEG you should specify an explicit width or height rather than scale, since bitmap images have no intrinsic size, nothing corresponding to Bounding Box information, although graphicx seems to use 72 pixels per inch as a default size for bitmap images 2 cm, 2cm, 2 cm, 2 cm.

From here we use Iwona font:

With PNG or JPEG you should specify an explicit width or height rather than scale, since bitmap images have no intrinsic size, nothing corresponding to Bounding Box information, although graphicx seems to use 72 pixels per inch as a default size for bitmap images.

If the font should be only used for a single word, it can also be specified `this way!`

Figure 2.4: Bow of Titanic

2.6 How to Refer to Literature

Throughout creation of the document you can dynamically build up a literature database. Note that when using or changing references, the document has to be compiled twice. References should be numbered and appear in the order they appear in the text. This is achieved by listing the references in exactly this order in the file *bib.tex*. When referring to a reference in the text of the document, the number of the reference should be put into square brackets. This is already done by the template.

Below you will find the description of the different citation styles according to IEEE. Examples can be found in the Bibliography.

- **Print References**
  - **Book** [1]
    Author(s). *Book Title.* Location: Publishing company, year, pp.
  - **Book Chapters** [2]
    Author(s). "Chapter Title" in *Book Title*, edition, volume. Editors name, Ed. Publishing location: Publishing company, year, pp.
  - **Article in a Journal** [3]
    Author(s). "Article Title". *Journal Title*, vol., pp, date.
  - **Articles from Conference Proceedings (published)** [4]
    Author(s). "Article Title." in *Conference Proceedings*, year, pp.
  - **Papers Presented at Conferences (unpublished)** [5]
    Author(s). "Paper's Title," Conference Name, Location, year.

- **Standards/Patents** [6]
  Author(s)/Inventor(s). "Name/Title." Country where the patent is registered. Patent number, date.

- **Electronic References**
  - **Books** [7]
    Author. (year, Month day). *Book Title.* (edition). [Type of medium]. Vol. (issue). Available: site/path/file [date accessed].
  - **Journal** [8]
    Author. (year, Month). "Article Title." *Journal Title.* [Type of medium]. Vol. (issue), pages. Available: site/path/file [date accessed].
  - **World Wide Web** [9]
    Author(s).[2] "Title." Internet: complete URL, date updated[2] [date accessed].

- **Odd Sources**
  - **Newspaper** [10] [11]
    Author(s)[2]. "Article Title." *Newspaper* (month, year), section, pages.
  - **Dissertations and Theses** [12]
    Author. "Title." Degree level, school, location, year.
  - **Lecture** [13]
    Lecturer(s). Occasion, Topic: "Lecture Title." Location, date.
  - **E-mail** [14]
    Author. "Subject line of posting". Personal E-mail (date).
  - **Internet - Newsgroup** [15]
    Author or Topic[2], "Title," Complete network address, date when it was updated [date accessed].

[2]Can be excluded if not available.

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List of Abbreviations

LNA	Low Noise Amplifier
VGA	Variable Gain Amplifier
MOS	**M**etal **0**xide **S**emicondictor
SPICE	Simulation Program with Integrated Circuit Emphasis
BSIM	Berkeley Short-channel IGFET Model refers to a family of MOSFET transistor models for integrated circuit design
VHDL	**V**ery High Speed Integrated Circuit **H**ardware **D**escription **L**anguage

Appendix A

Source Code

A.1 Template File Formats

A.1.1 HSPICE

```
HEADER_FIRST: .SUBCIRCUIT &!cell_name &%I &%O &%IO &%S &@BulkNode
PIN_INFO: *.PININFO &( &%I : I &) \&( &%O : O &) &( &%IO : IO &)
STOP_VIEW: M &^ &!inst_name &@d &@g &@s &@BulkNode nmos w= &@w l= &@l
INSTANCE: X &^ &!inst_name &%I &%O &%IO &!cell_name
```

A.1.2 VHDL

```
HEADER_FIRST ENTITY &!cell_name IS \n
    \t PORT( \n  \t &( &%I : IN std_logic; \n
    &)  \t &( &%O : OUT std_logic; \n
    &) ); END &!cell_name NULL

PIN_INFO \n ARCHITECTURE madebyTDI of &!cell_name IS \n
    \t &( SIGNAL &( &%I : std_logic; \n
    &)  \t &( &%O : std_logic; \n
    &) BEGIN NULL

INSTANCE \t X &- &!inst_name : &!cell_name \n
    \t PORT MAP( \n
    \t  \t  &( IN => &%I , \n
    &) \t   \t  &( OUT => &%O , \n
    &) );  NULL

FOOTER END madebyTDI; NULL
```

A.2 Generated Netlists

A.2.1 HSPICE

```
**  Cell 'c_inv', library: 'cmoslib', path
** '/opt/tech5/cmos/.dr/cmoslib/v2.1/cdb/cmoslib', vers 'vnil'
.SUBCKT c_inv in0 out0 hSup lSup nBulk pBulk n0L=1.0 n0W=1.0 p0L=1.0 p0W=1.0
*.PININFO in0:I out0:O

** The following net names were mapped:
** OriginalName: net11 mapped to: hSup
** OriginalName: net10 mapped to: lSup

Mn0 out0 in0 lSup nBulk nmod  w='n0W*GEONSHRNK-2*GEONDEL2'
+ l='n0L*GEONSHRNK-2*GEONDEL1'
Mp0 out0 in0 hSup pBulk pmod  w='p0W*GEOPSHRNK-2*GEOPDEL2'
+ l='p0L*GEOPSHRNK-2*GEOPDEL1'

.ENDS

**  Cell 'roli_einfach', library: 'rol', path
** '/home/sab_kurs/fw1.1.1/v1.0.0/home/leng/lib_rol/rol', vers 'vnil'
XIN0 input output VDD VSS VSS VDD c_inv n0L=n0L p0L=p0L n0W=n0W p0W=p0W
```

A.2.2 VHDL

```
--Netlist:
--Time: Tue Jan 11 11:41:47 2000
--By: leng

--Library=cmoslib,Cell=c_inv,View=native
LIBRARY IEEE,cmoslib,proj_vhdl,proj_verilog;
USE IEEE.std_logic_1164.all;
USE work.all;
USE cmoslib.cmoslib.all;

ENTITY c_inv IS
     GENERIC (
          n0L : real := 1.0;
          n0W : real := 1.0;
          p0L : real := 1.0;
          p0W : real := 1.0
     );
     PORT(
          in0 : IN std_logic;
          out0 : OUT std_logic
```

```
    );
END c_inv;

ARCHITECTURE madebyTDI OF c_inv IS
    SIGNAL VSS : std_logic;
    SIGNAL VDD : std_logic;

    SIGNAL out0_ylw : std_logic;

BEGIN

    VSS <= '0';
    VDD <= '1';
    out0 <= out0_ylw;
    Mn0 : c_ntrans
        PORT MAP(
            d => out0_ylw,
            s => VSS,
            g => in0
        );

    Mp0 : c_ptrans
        PORT MAP(
            d => out0_ylw,
            s => VDD,
            g => in0
        );

END madebyTDI;
```