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INFORMATION TECHNOLOGY



Chair of Electric Power Networks and Renewable Energy Sources

Master Thesis

Title

Submitted on XX.XX.XXXX

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FAKULTÄT FÜR ELEKTROTECHNIK
UND INFORMATIONSTECHNIK



Master's thesis

for Ms./Mr. Xx xx

Topic: Development of a...

Task:

The optimal design

The study has to cover the following points::

- Literature research
- Representation
- Documentation of the results

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Chairman examination board

Declaration of Independence

I assure that I have written this master thesis independently without external help and used only the given sources and aids. Literally or meaning points, which were obtained from other works are labeled with their source.

Surname, Forename

Location, XX.XX.XXXX

Abstract

At the beginning of a scientific work there is always an abstract. This is shortest and most concise summary of the content of the work. It should not exceed the size of one page. The abstract should arouse the interest of the reader. If the abstract is meaningless or even bad, nobody will look at the rest of the work. Often the Abstract is included in English in addition to the native language. The abstract must be different from the final summary and is part of the work.

Kurzzusammenfassung

Am Anfang einer wissenschaftlichen Arbeit steht immer eine Kurzfassung/Abstract. Dies ist eine möglichst kurze und prägnante Zusammenfassung des Inhaltes der Arbeit. Sie sollte den Umfang einer Seite nicht überschreiten. Die Herausforderung ist hierbei, das Interesse des Lesers zu wecken. Ist die Kurzfassung aussaglos oder gar schlecht, so wird sich niemand den Rest der Arbeit ansehen. Oft ist der Abstract neben der Muttersprache auch in Englisch enthalten. Der Abstract hat sich von der Schlusszusammenfassung zu unterscheiden und ist Teil der Arbeit.

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List of Symbols

Symbols printed in bold depict vectors and matrices.

Physics Constants

c	Speed of light in a vacuum inertial system	299, 792, 458 m/s
g	Gravitational Constant	$6.67384 \times 10^{-11} \text{ N m}^2/\text{kg}^2$
V	Constant Volume.	
h	Plank Constant	$6.62607 \times 10^{-34} \text{ J s}$

Number Sets

\mathbb{C}	Complex Numbers.	\mathbb{R}	Real Numbers.
\mathbb{H}	Quaternions.		

List of Abbreviations

DIN Deutsches Institut für Normung

1 Introduction

With this template, a computer running \LaTeX and a basic understanding of the \LaTeX language, an author can produce professional quality typeset research reports quickly, inexpensively, and with minimal effort. The purpose of this example thesis is to serve as a user guide.

It is assumed that the reader has at least a basic working knowledge of \LaTeX . Those so lacking are strongly encouraged to read some of the excellent literature on the subject [1]–[3]. In particular, Tobias Oetiker’s *The Not So Short Introduction to $\text{\LaTeX} 2_{\epsilon}$* [2], which provides a general overview of working with \LaTeX and Michael Downes’ *Short Math Guide for \LaTeX* [3], which focuses on the formatting of mathematical equations, are both available for free online.

General support for \LaTeX related questions can be obtained on the internet.

2 General Settings

Before you start using this template, you need to adjust a few things. These adjustments are described in detail in the following subsections. All document settings are located in the *settings.tex* file. In general, change the default settings only if necessary and if you know what you are doing.

2.1 Class Options

There are a number of class options that can be used to control the overall mode and behavior of this template. These are specified in the traditional L^AT_EX way:

```
\documentclass[
  a4paper,
  12pt,
% twoside,%      Uncomment if you want to print on both sides
  parskip=half,
  bibliography=totoc,
  toc=listof,
  listof=entryprefix,
  numbers=noenddot,
  BCOR=1cm,
  DIV=11,
]{scrartcl}
```

This command is included in the *settings.tex* file. Explanations for all selected options can be found in the comments. The default values should not be changed.

There are only two exceptions. The value for the binding correction BCOR should be specified by the user. It specifies the width of area lost from the paper during the binding process. The value can be entered in any valid unit, e. g., BCOR=0.5 cm for half a centimeter of binding loss on the left page margin. The default setting is BCOR=1cm.

If the user wants to print double-sided, he must uncomment the `twoside` option. This saves a lot of paper. The default setting is single-sided printing.

2.2 Page Margins

L^AT_EX calculates the the size of type area according to typographical specifications,

where the ratio of left, top, right and bottom margins is 5:5:5:8. This ratio is based on the golden ratio and creates an aesthetically pleasing type area according to typographic criteria. The use of the popular `geometry` package and the manual definition of page margins should be avoided at all costs.

The document class option `DIV` is used to adjust the page margins while maintaining the type area size. For the default font size 12pt the setting `DIV=11` is recommended and set as default.

2.3 Set the Language and Type-of-Report

The author is free to write in English or German. The language setting must be adapted according to your choice. You must also tell the template what type of research project you are working on. This means whether you are writing your master thesis or the report of your non-technical-project or any other research project. This choice affects the title page of your document.

To make the right settings for your document, you need to select the right tags in the *settings.tex* file. For this you have to comment out the desired tags from the following list:

```
% Language Tag
    usetag{english}
    %\usetag{german}
% Type-of-Report Tag
    \usetag{thesis}
    %\usetag{researchProject}
    %\usetag{phd}
```

Table 1: Settings Depending on the Type of Student Research Project

	Language Tag	Type-of-Report Tag
Master thesis	english	thesis
Bachelor thesis	english	thesis
Non technical project	english	researchProject
Bachelor research project	english	researchProject
Masterarbeit	german	thesis
Bachelorarbeit	german	thesis
Forschungsprojekt Master	german	researchProject
Forschungsprojekt Bachelor	german	researchProject

```
%\usetag{report}
```

The combinations relevant for student research projects can be found in table 1. Make sure that all other unused tags are commented. The default setting of the template is a Master or Bachelor thesis written in English. After changing this settings you have to compile two times the document (first compilation will fail).

2.4 Language Package and Hyphenation

By selecting a language tag, the corresponding language package is automatically loaded. This includes loading the correct hyphenation of the selected language. \LaTeX automatically hyphenates words whenever necessary. If the hyphenation algorithm does not find the correct hyphenation points, you can remedy the situation by using the following commands to tell \TeX about the exception. The command,

```
% set the hyphenation for certain words
\hyphenation{op-tic-al net-works semi-con-duc-tor}
```

causes the words listed in the argument to be hyphenated only at the points marked by „-“. This command is located in the *settings.tex* file and can be customized by the author if necessary.

2.5 The Title Page

Depending on the selected tags for language and type-of-report (explained in subsection 2.3), the correct title page for your work is automatically inserted. Locate the selected title page file in the directory `../Sections/_General`. The name is in the form:

```
titlepage_<Type-of-Report Tag>_<Language Tag>.tex
```

Open the right title page file and customize it. Replace the title and all names and dates with the correct ones. Take the information from your original task sheet. Add your student ID.

Titles are generally capitalized except for words such as *a, an, and, as, at, but, by, for, in, nor, of, on, or, the, to* and *up*, which are usually not capitalized unless they are the first or last word of the title. Line breaks (`\`) may be used to equalize the length of the title lines. Do not use math or other special symbols in the title.

2.6 The Task Sheet

To add your signed task sheet to the thesis, first make a scan of it. The scan should be in color, of good quality, and in PDF-format. An example scan is in the directory `../Sections/_General`, named as `Task_Sheet_MA.pdf`. Replace this file with your scan to add it to the L^AT_EX-document.

2.7 The Declaration of Independence

Depending on the selected tags for language and type-of-report (explained in subsection 2.3), the correct declaration of independence for your work is automatically inserted. Locate the selected declaration of independence file in the directory `../Sections/_General`. The name is in the form:

```
doi_<Type-of-Report Tag>_<Language Tag>.tex
```

Open the right declaration of independence file and customize it. Replace the name, place and date with the correct ones. Sign the declaration of independence before you submit your thesis.

2.8 The Abstract

Always write the abstract in English and German. The abstract files can be found in the directory `../Sections/Abstract`. The English abstract should be written into the *abstract.tex* file, the German one into the *kurzzusammenfassung.tex* file.

The abstract is generally the first part of a thesis. Math, special symbols and/or citations should generally not be used in abstracts.

3 Format Instructions

In the following subsections you will find instructions and examples on how to use this template for your work. The quality of your report will increase if you follow these guidelines.

3.1 Sections

Sections and their headings are declared in the usual \LaTeX fashion via,

```
\section
  \subsection
    \subsubsection
      \paragraph
```

Further levels in the structure should be avoided.

Define your sections (not subsection, subsubsection...) together with the following command,

```
\thispagestyle{firstPage}
\section{Format Instructions}
```

This suppresses the section heading in the header of the current page. Please compare the header of this and the next page to see the result.

3.2 Skip Between Paragraphs

In \LaTeX , paragraphs are ended by leaving a blank line between the end of the previous and the beginning of the next paragraph, never through a combination of end-line \backslash or new-line \backslash newline commands. It should hardly ever be necessary in normal text to use \backslash or \backslash newline.

3.3 Symbols

All symbols should be stated in the *List of Symbols*. Issue the \backslash addsymbol command for each symbol you want to have included in the list of symbols. The best place for this command is immediately after you introduce the symbol for the first time. Alternatively you can define symbols in the *nomenclature.tex* file.

The command `\addsymbol` has four arguments:

```
\addsymbol{prefix}[sort order]{symbol}{description}
```

See the *nomenclature.tex* file for some examples. The *prefix* is used for fine tuning the sort order, *symbol* is the symbol you want to describe and *description* is the actual description. To enter units and at the end of the description argument use the `\nomunit` command. The *unit* argument is internally enclosed in the `\si` command from the `siunitx` package. Therefore, the syntax of this popular package can be used if wanted.

It often makes sense to separate index entries into several groups according to their meaning. The *prefix* parameter provides a way to do it. Therefore, start the prefix with the letter of the wanted subgroup. There are five groups defined by default in the *nomenclature.tex* file with the `\newsymbolclass` command. This command allows you to create columns in your *List of Symbols*.

```
\newsymbolclass[number of columns]{prefix}{title}
```

This creates a "Symbol Class" called `<title>` and is printed in the Nomenclature with `<ncols>` columns. The *description* argument is also the title of the symbol group which is printed in the *List of Symbols*. The defined groups appear in the order of the declaration of the symbol class. A more detailed description of the usepackage can be found at <https://bit.ly/36bYkN1>.

To print your *List of Symbols* compile at first through \LaTeX . This will instruct \LaTeX to open the nomenclature file *MainDocument.nlo* and to write the information from your `\addsymbol` commands to this file. The next step is to invoke the *MakeIndex* compilation. You should instruct *MakeIndex* to use *MainDocument.nlo* as your input file, use `nomencl.ist` as your style file and write output to the file *MainDocument.nls*. How to do this depends on your implementation of the *MakeIndex* compilation or on your \LaTeX text editor. For example, within the *TexMaker* editor, select *Configure Texmaker* under Options. Select the Command window and write `makeindex %.nlo -s nomencl.ist -o %.nls` at *MakeIndex*. After successful *MakeIndex* compilation, you have the *MainDocument.nls* file that contains your nomenclature list properly ordered. The last step is to invoke the standard \LaTeX compilation once more to process the nomenclature within the main document.

3.4 Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as SI, AC, or DC do not have to be defined. Abbreviations that incorporate periods should not have spaces:

write “C.N.R.S.”, not “C. N. R. S.” Do not use abbreviations in the title unless they are unavoidable.

All acronyms are defined in the *acronyms.tex* file. Then you can refer to them in the text using the commands shown in Table 2.

Table 2: Commands to Call Acronyms

command	description	appearance
<code>\ac{din}</code>	first use	Deutsches Institut für Normung (DIN)
<code>\ac{din}</code>	second use	DIN
<code>\acl{din}</code>	force the long version	Deutsches Institut für Normung
<code>\acs{din}</code>	force the short version	DIN
<code>\acf{din}</code>	force the full version	Deutsches Institut für Normung (DIN)
<code>\aclp{din}</code>	force the plural version	Deutsches Institut für Normungs
<code>\acfi{din}</code>	force the italic version	<i>Deutsches Institut für Normung</i> (DIN)
<code>\ac*{din}</code>	first use, don't mark used	DIN

3.5 Math

A popular package from the American Mathematica Society that provides many useful and powerful commands for dealing with mathematics is the `amsmath` package. Mathematical symbols are provided by the `amssymb` package. Both packages are loaded by default in the *settings.tex* file.

For math formulas that are displayed inline, use the `$. . . $`-environment. Single line equations are created using the traditional `equation` environment. Each equation should be numbered on the right-side. For example, the following code:

```
\begin{equation}
  \label{eq:example}
  \int^{\infty}_1 \frac{1}{x^2} \mathrm{d}x = \left[ -\frac{1}{x} \right]_1^{\infty} = 1
\end{equation}
```

generates the following example equation:

$$\int_1^{\infty} \frac{1}{x^2} dx = \left[-\frac{1}{x} \right]_1^{\infty} = 1 \quad (3.1)$$

Do not use environments without an equation number like `equation*`. When referring to equations, do not use the word “equation”, but rather just enclose the equation

number in parentheses. Therefore, you can use the `eqref` command. For example, `\eqref{eq:example}` generates (3.1). For multiline equations you can use the `align` environment for example.

The Greek letter pi is always italic in the standard L^AT_EX font, thus `$$\pi$` produces π . For a non-italic pi use the command `\cpi` in math environments to generate π . To set all other Greek letters non-italic, the `upgreek` package is loaded by default in the `settings.tex` file. Thus, in math environments `\upmu` generates μ instead of μ or `\upepsilon` generates ϵ instead of ϵ .

To correctly typeset values with units, the `siunitx` package is loaded by default in the `settings.tex` file. Whether you want to use it is up to you. Both following codes are equivalent. In the left code the unit is set with the `siunitx` package, while in the right code everything is set manually:

<pre>\begin{equation} \SI{1}{\metre\per\second} \end{equation}</pre>	<pre>\begin{equation} 1\,, \frac{\mathrm{m}}{\mathrm{s}} \end{equation}</pre>
$1 \frac{\text{m}}{\text{s}}$	$1 \frac{\text{m}}{\text{s}}$

3.6 Highlighting Text

The less highlights are used, the clearer the text becomes.

Italicized text should be used for highlighting and for Latin terms.

Bold text for highlighting should be avoided.

Underlined text is generally prohibited.

SMALL CAPS are used to emphasize concise words and short passages. In longer sections, however, they are difficult to read.

Letterspacing should be avoided like bold text.

3.7 Figures

To insert figures, the `graphicx` package is loaded by default in the `settings.tex` file. Figures are handled in the standard L^AT_EX manner. For example, the following code generates figure 3.1:

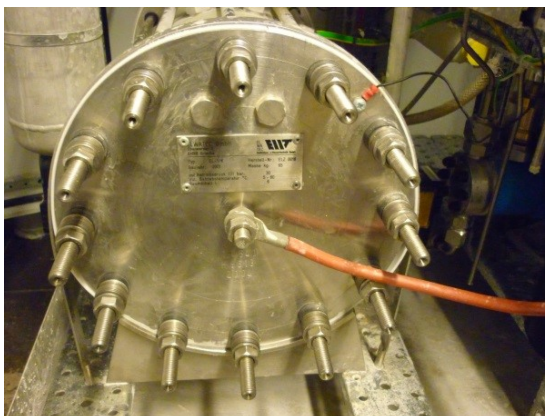


Figure 3.1: Alkaline electrolysis cell with reference [4].

```

\begin{figure}
  \centering
  \includegraphics[width=0.5\textwidth]{Chapter_3/Photo_1}
  \caption[Short caption without reference]...
    {Alkaline electrolysis cell with reference \cite{lana2020}.}
  \label{fig:example}
\end{figure}

```

Note that the caption follows the graphic and any labels must be declared after (or within) the caption command. The caption text should end with a punctuation mark. Third-party figures must contain a reference to the source. Figures made by the author himself do not require a reference. Each figure with reference should have an additional short caption, as shown in the example code. This short caption is listed in the List of Figures at the beginning of the document (No referencing should appear there). The same applies to the List of Tables.

Users should ensure that all non-photo figure use a vector format. Preferred formats for vector graphics are *.eps, *.pdf, and *.mps. For photos, the bitmapped formats *.jpeg and *.png are preferred. Save your figures in the directory ../Figures, so that you do not have to specify the full path with every instance of \includegraphics.

For subfigures, the subfig package is loaded by default in the *settings.tex* file. The following example code generates figure 3.2, consisting of two subfigures:

```

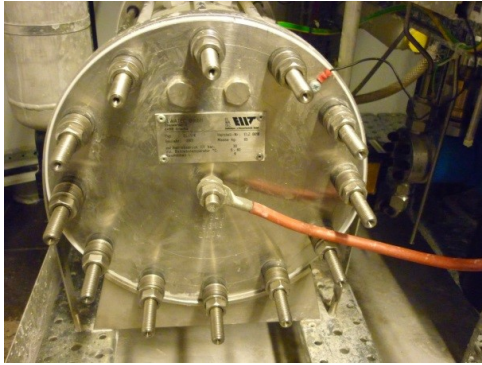
\begin{figure}[h]
  \centering
  \subfloat[Case I]{\includegraphics[width=2.5in]{Chapter_3/Photo_1}}
  \label{subfig:first_case}
  \hfill
  \subfloat[Case II]{\includegraphics[width=2.5in]{Chapter_3/Photo_1}}

```

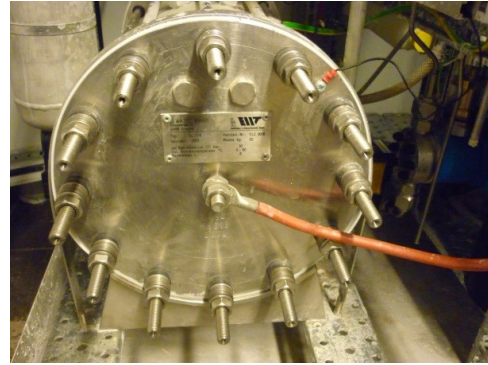
```

\label{subfig:second_case}}
\caption[Short captions are also useful with long captions]{Simulation...
results for the network XYZ. The measurements were obtained with an...
oscilloscope at a sample rate of 2.5\,GS per s on a rainy afternoon...}
\label{fig:Subfigure}
\end{figure}

```



(a) Case I



(b) Case II

Figure 3.2: Simulation results for the network XYZ. The measurements were obtained with an oscilloscope at a sample rate of 2.5 GS per s on a rainy afternoon...

Note how captions and labels can be tagged to each of the subfigures as well as to the overall figure. Note that the total width of all the subfigures on a line must be less than the text width or else an unwanted line break will occur. Multiple lines of subfigures can be used within one figure if needed.

The use of optional placement arguments, such as [h] in the example subfigure, should rarely be necessary. Using it with every figure is not recommended and is a poor programming style. The use of the popular `float` package is even worse. In general do not use a floating environment, like `figure` or `table`, if you do not want it to float.

3.8 Tables

Tables are handled in a similar fashion as figures, but with a few notable differences. For example, the following code generates Table 3:

```

\begin{table}
\renewcommand{\arraystretch}{1.2}
\caption{A Simple Example Table}
\label{tab:example}
\centering

```

```

\footnotesize
\begin{tabular}{cc}
\toprule
\bfseries First & \bfseries Next\\
\midrule
Parameter 1 & Value 2.0\\
Parameter 3 & Value 4.0\\
\bottomrule
\end{tabular}
\end{table}

```

Note that table captions are placed before the tables and, given that they serve much like titles, are usually capitalized except for words such *as a, an, and, as, at, but, by, for, in, nor, of, on, or, the, to* and *up*, which are usually not capitalized unless they are the first or last word of the caption. Each table caption with reference should have an additional short caption argument. When using the `tabular` environment to construct tables, it is usually a good idea to increase the value of `\arraystretch` above unity to “open up” the table rows a tad. Also, tables with “open sides” are preferred. The text inside tables should be smaller than the normal font, so the `\footnotesize` command must be used.

For tables longer than one page, use the `longtable` package, which is loaded by default in the `settings.tex` file.

3.9 Appendix

You can easily implement an appendix if it is needed. To include the appendix use the following statement:

```

% Appendix
\pagenumbering{roman} % small roman page numbers
\appendix
\tagged{english}{\addcontentsline{toc}{section}{Appendix}}

```

Table 3: A Simple Example Table

First	Next
Parameter 1	Value 2.0
Parameter 3	Value 4.0

```
\tagged{german}{\addcontentsline{toc}{section}{Anhang}}
\input{Sections/Appendix/Appendix_A}
```

If you use the command `\include` instead of `\input`, the heading *Appendix* is not placed correctly in the *Table of Contents*.

If you want your appendix with more than one part, you can add more sections to your appendix. This you can do by using:

```
\include{Sections/Appendix/Appendix_B}
```

3.10 Bibliographies

Bibliographies are most easily (and correctly) handled using the `literature.bib` file and BibTeX. If BibTeX is used, compile the following way `latex→bibtex→latex→latex`. The bibliography is invoked via:

```
\bibliographystyle{ieeetr}
\bibliography{literature}
```

Do not change the bibliography style.

To manage your research project references, it is recommended to use a reference management software like *JabRef* or *Citavi*. With such a software you only need to open the `literature.bib` file and edit the database. This database is included with the `\bibliography{literature}` command within the *MainDocument.tex* file. By compiling with BibTeX, the necessary `*.bbl` file is automatically generated.

The database holds examples for referring to books [1] and articles [5]. There is no specific template to cite web pages using BibTeX. Instead, you can use a customized book-entry within your database. See the following example, which generates [4]:

```
@Book{lena2020,
  author    = {Max Mustermann},
  publisher = {Otto von Guericke University Magdeburg},
  title     = {\textit{LENA WebPage}},
  year      = {2020},
  month     = {October},
  note      = {\url{https://lena.ovgu.de/}, Accessed on: 11/24/2020},
}
```


3.11 References

References are made with the `\cite` command as usual. This will produce citation numbers that are individually bracketed [1]. By calling the `cite` package, the citation numbers will automatically be sorted and compressed. This package is loaded by default in the `settings.tex` file. Multiple adjacent citations should always all be declared within a single `cite` command and comma separated, e. g. `\cite{Source1, Source2, Source3}` (e. g. [1]–[3]).

3.12 Some Common Mistakes

Mathematical variables like x or m and functions like $y = f(x)$ are always in italic font. Numbers and special mathematical functions (e. g. $\lim(x)$, $\sin(x)$, $\cos(x)$, e^x , $\ln(x)$), arithmetic symbols and unit symbols (50 μmol , 20 cm) are not to be set in italic font. Make sure that there is always a protected space between a value and its unit, e. g. `1\,V` generates 1 V instead of 1V. Alternatively you can use the `siunitx` package, which automatically inserts this space, see subsection 3.5. The same applies to common abbreviations like `e.\,g.` or `i.\,e.` which should have a protected space between the letters.

As multiplication sign you have to use the center dot `\cdot` or `\times`, but never the asterisk `*` or letter `x` from your keyboard.

Table 4 gives an overview of the used fonts for symbols and indices:

Indices are set upright or italic according to the recommendations of Table 4. For example,

upright		italic	
C_g	(g : gaseous)	C_p	(p : Pressure)
g_n	(n : normal)	a_n	(n : Running Index)
E_k	(k : kinetisch)	g_{ik}	(i, k : Running Indices)
X_e	(e : elektrisch)	p_x	(x : Coordinates)
$T_{1/2}$	(1/2 : einhalb)	l_λ	(λ : Wavelength)

If there are several indices at one variable, they are separated by comma or by a space

Table 4: Usage of Upright and Italic Fonts out of DIN 1338

Nr	Subject	Font	Example	Note
1	Numbers			
1.1	Written in digits	upright	$1, 32 \cdot 10^6$	Also applies to roman numerals.
1.2	Written in letters (variables)	italic	$\sqrt[3]{3}; (a_{ik}); n\text{-fach}$	
1.3	Written in letters (fixed meaning)	upright	$\pi = 3, 14159\dots$ $e = 2, 71828\dots$ $i = j = \sqrt{-1}$	In mathematical literature the letters are unfortunately often set in italic
2	Physical symbols	italic	M (Moment) m (Mass) C (Capacity)	Vectors/Tensors are to be set bold and complex numbers are to be underlined
3	Functions/Operators			
3.1	Free meaning signs	italic	$f(x); g(x)$ $L(x) = y^2 + f_1 y$	
3.2	Fixed meaning signs	upright	$d; \delta; \Delta; \int; \Sigma; \Pi$ div; lim; Re sin; lg; Γ exp; ln; δ	
4	Units	upright	m (Meter) C (Coulomb) F (Farad) mm (Millimeter) μF (Microfarad)	
5	Abbreviations	upright	US (United States) BER (bit error ratio)	

and they are set on the same level. For example,

Z_{ij}	Impedance between port j and port i
$a_{n,m-1}$	Value of a_{ik} at $i = n$ and $k = m - 1$
$U_{1,min}$	minimum primary voltage
$F_{Gz} = F_{G,max}$	Gravitational force in z – direction equals maximum one

3.13 Diagrams

Ensure that all diagrams are of uniform size and style. Axis labels should be in the following way: P_{el} in W.

References

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- [5] J. Lofberg, “YALMIP : a toolbox for modeling and optimization in MATLAB,” in *2004 IEEE International Conference on Robotics and Automation (IEEE Cat. No.04CH37508)*, IEEE, 2004.

A Appendix A

In the annex are set all important information in the context of the work, that are not necessary in the main part for the immediate understanding or affecting the flow of reading (e. g. extensive measurement results, tables, questionnaires of empirical surveys, algorithms, code, screenshots).

Annexes are optional and are not counted with the normal division (1, 2, 3, ...). They get their own breakdown in capital letters (A, B, C, ...)

B Appendix B