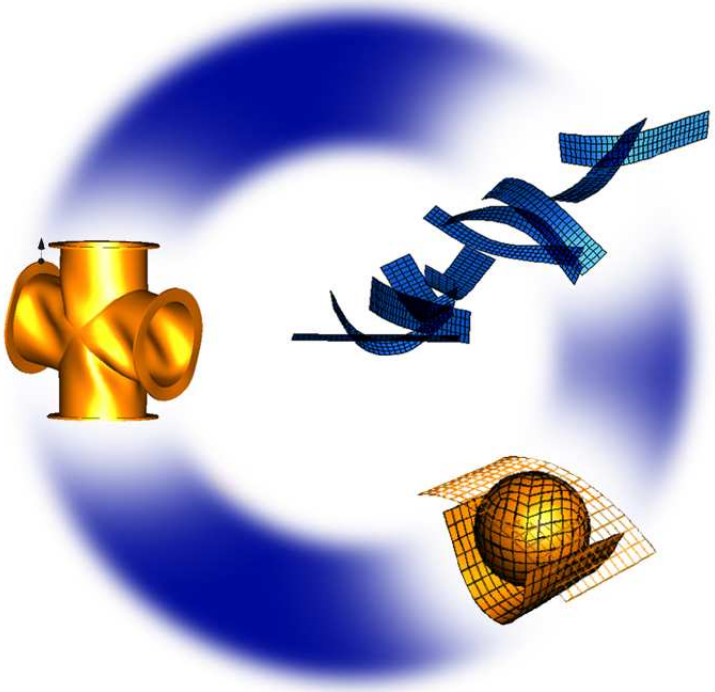
Technische Universität München

LaTeX-template for LNM theses

AuthorName

TypeOfThesis



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Boltzmannstraße 15
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Titel der Arbeit (deutsch und englisch, wenn Volltext englisch, nur englischer Titel notwendig)

Wissenschaftliche Arbeit zur Erlangung des Grades
B.Sc./M.Sc.
an der TUM School of Engineering and Design.

Themenstellender	Univ.-Prof. Dr.-Ing. Wolfgang A. Wall Lehrstuhl für Numerische Mechanik
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Erklärung

Ich versichere hiermit, dass ich die von mir eingereichte Abschlussarbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt habe.

(Ort, Datum, Unterschrift)

Acknowledgement

If desired.

Abstract

The abstract should be provided in German and English.

Contents

1 Introduction

The purpose of this document is two-fold:
Firstly, this is a plain and simple template with the most basic LaTeX-commands and structures introduced that are needed for writing a thesis in LaTeX. It should be sufficient for 95% of the theses submitted at LNM - this means that completeness is not claimed. It is recommended to stick to these basic suggestions, knowing that other - possibly better - philosophies or styles exist. In case a more complex structure is needed, refer to literature or the web, although you should think twice about introducing a much more complex structure.
Secondly, this report gives some basic suggestions on what the structure of the report should look like and also some brief description about typically expected content.
Please note:

- Significant changes to the document style, layout and structure should only be done according to prior agreement with your supervisor.
- compile the template with the following command
  `latex LaTeX_template_v03.tex && dvipdfm LaTeX_template_v03.dvi`
- if warning "undefined references" is thrown, include references in BibTeX-file and run command
  `bibtex LaTeX_template_v03`

2 Fundamentals of LaTeXI: structure

2.1 Sections

The following section type may be used:

```
\section[TitleInTOC]{FullTitle}\label{sec:SectionLabel}
\subsection[TitleInTOC]{FullTitle}\label{sec:SubsectionLabel}
\subsubsection[TitleInTOC]{FullTitle}\label{sec:SubsubsectionLabel}
```

If case you need even more structure depth, you can also use

```
\paragraph{Title}
\subparagraph{Title}.
```

However, you cannot reference (sub-)paragraphs. Think about whether you really need them or if changing the structure might be better. Making it less complex usually makes it easier to read (and write!).

It is recommended to write special characters like the German ß, ä, ö, ü, etc. in TeX-code without any packages, i.e. `\ss`, `\"a`, `\"o`, and `\"u`. This in general prevents difficulties if somebody else is compiling parts of your work who might not use those packages. You will quickly get used to it!

2.2 Floats

2.2.1 Figures

Figures are to be included in the float environment `\figure` as follows

```
\begin{figure}[placement specifier]
  \centering
  \includegraphics[width=0.3\textwidth]{NameOfGraphic}
  \caption{Description of graphic.}
  \label{fig:GraphicLabel}
\end{figure}.
```

The size of the graphic (height or width) should be defined relative to the textheight or -width, respectively. Two figures next to each other are included by

```
[...]
\includegraphics[width=0.3\textwidth]{NameOfGraphic_1}~
\includegraphics[width=0.3\textwidth]{NameOfGraphic_2}
[...],
```

where as figures on top of each other are included by

```
[...]
\includegraphics[width=0.3\textwidth]{NameOfGraphic_1}\\
\includegraphics[width=0.3\textwidth]{NameOfGraphic_2}
[...].
```

The placement specifier defines where the figure should be placed *approximately*. This can be `h`, `t`, `b`, or `p` which stands for `here`, `top of page`, `bottom of page`, or `own page for floats`. In 90% of the cases, LaTeX knows best where to put the floats - leave it out. Trying to put the figures exactly where you want to put them using `h` is a time waster and counts as procrastination. The history of students - including me - trying to be smarter than LaTeX is as old as LaTeX itself - if not older. Nobody succeeded. If you do decide to use it after all, try it right before printing the (very, very) final version.

Note that no endings should be set to the graphic's name. Compiling with `latex` will automatically choose vector graphics with this name, in contrast to `pdflatex` that will include raster graphics. Let LaTeX choose the appropriate format - just make sure that you provide a graphic of an appropriate format in the given graphic path (see "Lead up" in header file).

2.2.2 Tables

Similar to section 2.2.1, tables are to be included in a float environment, namely `table`, as follows:

```
\begin{table}[placement specifier]
  \begin{tabular}{rcl}
    line 1 column 1 & column 2 $ column 3\\
    line 2 column 1 & column 2 $ column 3
  \end{tabular}
  \caption{Description of table.}
  \label{tab:TableName}
\end{table}
```

`rcl` stands for `right`, `center`, and `left` and referres to the alignment of the column. "`|`" inbetween will separate the columns by a vertical line. `\hline` after, e.g. `\\` inserts a horizontal line after the line (see also table 1 below). LaTeX-tables are far from perfect if your table gets a bit more complex, e.g. when inserting bigger equations. Formatting tables to someones total satisfaction can be very tricky and trying to be too fancy is again mostly a time waster. Keep it simple!

2.3 Equations

Equations with numbering should be included by the `align` environment like this

```
\begin{align}\label{eq:EquationName}
  f(x) := \exp(x) &= \sum_{n=0}^{\infty} \frac{x^{n}}{n!} \nonumber \\
                  &\approx 1 + x + \frac{x^{2}}{2} + \frac{x^{3}}{6}
\end{align}
```

for

$$f(x) := \exp(x) = \sum_{n=0}^{\infty} \frac{x^n}{n!}$$
$$\approx 1 + x + \frac{x^2}{2} + \frac{x^3}{6}. \tag{1}$$

Use `\\` to insert a multiline equation. Use `&` to align those to each other as shown. It defines one `rl`-aligned pair, which means that everything that stands on the left of `&` will be right align and vice versa. The equation itself will be centered. Use `\nonumber` to surpress the numbering of certain lines as shown. If no numbering is wanted use `align*` and leave out the label. Look on the web for more complex alignments - see also the `alignat`-environment that could be used alternatively. Use it scarcely. `align` is powerfull and easy to use; it should be used most (meaning 99%) of the times.

Objects like vectors, matrices, and similar things should be formated consistently using a dedicated command defined in the beginning of youe LaTeX-file. See for instance above the definition of `\vec` for writing a vector $\boldsymbol{x}$. Thus, you can also read your equations in LaTeX-code more easily. Additionally the nomenclature of an object is changed by changing only one line in your header.

It is recommended to insert sub- and superscript as well as any manipulation of symbold like `\hat` etc. by using `{}` even when only one symbol is manipulated, e.g. `\hat{\vec{x}}_{i}` for $\hat{\boldsymbol{x}}_i$. It's good coding and can otherwise also be an ever recurring source of typos and compilation errors.

3 Fundamentals of LaTeXII: referencing

3.1 Sections, equations, figures, and tables

Everything that can be referenced should have a label. Otherwise use the non-referenceable version, e.g. the `align*` environment instead of `align`. This also means every proper section of your thesis should have a label. Furthermore, every equation that has a number should be important enough to be referenced and thus gets a label. Sometimes this can also be a sentence like "Equation (4) states the key result of this section." to emphasise its importance. If the equation is not referenced, it is not important and should not even have a number - use `align*`. Figures and tables always have a label und should always be referenced at least once. Some readers don't look at them before they are referenced in the text. Of course, things that cannot be referenced should never have a label.

The label should have a certain structure and start with a specifier according to the object it references, followed by a colon and the actual name of the label. An example would be `\label{sec:intro}` for the label of the first section "Introduction". The specifiers are given in table 1. Referencing a labelled objects is done by the command `\ref`, e.g. `\ref{sec:intro}`. Equations should always be referenced by `\eqref`, which automatically puts the brackets around the equation number (comes with an ams-package already included in this template).

object	**specifier**
(sub-)section	sec
equation	eq
figure	fig
table	tab
(appendix)	(app)

Table 1: Object specifiers for labels.

3.2 Citations

For citations you have to use BibTeX. For citing a reference, you use `\cite{LabelOfRef}` As label, it is suggested to use the surname of the first author, directly followed by the year, and, if there is more than one publication of that author in the that year, a lowercase letter in alphabetical order. For instance: `\cite{Brooks1982}` for article [**?**]. Others might prefer other systems, which is fine as long as it is consistent. If you use only a few references, adding them by hand to your BibTeX-file seems the easiest. If there are more references you might want to create your BibTeX-file by a reference software like Jabref.

4 The actual structure of your report

This section is added to show what the complete structure of your thesis might look like. Coincidentally, this is also the typical structure of a scientific report, and hence important to know anyway. The typical sections are discussed below, but some specifics might vary according to the type of research project. Please discuss the actual structure of your thesis with your supervisor.

4.1 Abstract

This is the most often read section. It will determine if someone actually bothers to read more of what you've written. Only write this section after you have completed your report. The abstract consist of only one paragraph, mostly limited to 200-300 words. Literally, a summary of your work. Write a sentence or two about each of the main sections of your report, as discussed in this section. When summarizing results, make the reader aware of the most important results (including numbers when applicable) and important conclusions or questions that follow from these.

4.2 Introduction

The objective of writing this section is to introduce the reader to the problem and also show that you understand the problem statement in the context of current knowledge in the field.

Any problem in science can be introduced by simply including the following sections:

1. Give background about the problem you are investigating.
2. Describe what has been done up to now to address this problem (and also refer to the literature in which this work has been done).
3. State the objective for taking on the current study or the hypothesis that will be tested in the current study.
4. Provide a single paragraph of the contents of the rest of the article (focusing on that which is reported in "Materials and Methods", "Results", "Discussion" and "Conclusions").

4.3 Materials and Methods

Describe the relevant materials, methods, tools, equipment, software, hardware, experimental setup, experimental conditions, general procedures, etc. so that someone else can repeat your study or judge the scientific merit thereof. Do not describe everything you did, or who did what (unless specified or relevant). This section is not a set of instructions! It rather describes the complete methodology used, so

that it can be reproduced by someone of similar skill. Keep it as concise as possible. Also provide the reader the name of the company that produced relevant equipment/software used and the country where the company is located.

4.4 Results

Here you must simply report on the results that you achieved. When reporting the results, provide a context to the reader, such as to describe the question that was addressed by reporting a specific result. Do not interpret any results here – leave this for the discussion! Do not show the same results in a figure and a table – choose the one which can best communicate your results. The most important aspect(s) of the results reported in a table or figure should be reported in the text while also referring to the table or figure. In other words, the text should complement the tables and figures. Results reported here can be raw data (obtained from instruments), converted data (obtained after converting raw data as described in the "Materials and Methods" section) or applicable numerical examples.

4.5 Discussion

Here you must provide an interpretation of your results and support for all your conclusions using what you have at your disposal – your results and generally accepted knowledge, such as published literature (if needed). Also describe the significance of your findings clearly. Commenting on the methods that you employed might also be relevant.

If your results agree with what you expected, describe the theory or previously described observations that your results delivered. If your results do not agree with what expected, explain why this might have happened. A lot can be learned from what did not work! You may also deduce alternative explanations if reasonable ones exist. Understanding and interpreting what the limitations of your study was or what went wrong is crucial for the general increase of scientific knowledge – and of course your own knowledge. Do not neglect this aspect of your discussion. Do not just dismiss your results as useless or inconclusive if it does not clearly align with your initially stated objective/hypothesis. Since you were doing very good scientific research, appropriately report on the limitations of your study, so that these limitations do not come across as shortcomings, thereby deeming your work of lower quality. Therefore, attempt to end your discussion section by motivating the significance of your results, even if your results have been shown to not be statistically significant/aligned with the initial objectives.

4.6 Conclusions

Concluding remarks should naturally come from the discussion described above. This is the *Grand Finale* of your report. This section consists of 2 parts at most. In the first part, repeat your most important finding. The last part should suggest existing challenges, potential future directions or recommendations for further studies.

Keep it concise!

4.7 References

In all of the sections prior to this section, a citation is made in the text which refers to a reference – i.e. a source where this information comes from. The full details of these references are then listed in the this section – the references.

Different styles of citation and accompanying referencing exist. The style refers to the order in which the author names are listed, information of the cited reference to be listed both in the text and also in the references section, formatting, punctuation etc., which should be consistently used throughout the report. The style to be used depends on the type of publication, e.g. book, journal, report, newspaper article, website.

For your report to be submitted to LNM, you must use the numerical system when you use any references in your work. This system of referencing basically consist of placing a number in-text (starting at "1", of course) next to where you want to indicate a reference. This reference is then fully described in the "References" section.

A First Appendix

B Second Appendix