**Fachgebiet
Dynamik und Betrieb technischer Anlagen**

This Is a Very Good Title That Illustrates What This Great Piece of Work Is All About and That Gives an Impression of What a Long Title Looks Like

Wissenschaftliche Arbeit zur Erlangung des Grades
Master of Science (M.Sc.)

vorgelegt von
M. Sc.
First name middle name last name

Matrikelnummer
XXXXXX

Unter der wissenschaftlichen Leitung von
Prof. Dr.-Ing. habil. Jens-Uwe Repke

Unter der wissenschaftlichen Betreuung von
My advisor, M.Sc.

Berlin, Januar 2026

Technische Universität Berlin
Fakultät III – Prozesswissenschaften
Institut für Prozess- und Verfahrenstechnik
Fachgebiet Dynamik und Betrieb technischer Anlagen

Eidesstattliche Erklärung

Deutsch

1) Hiermit versichere ich, dass ich die vorliegende Arbeit ohne Hilfe Dritter und ausschließlich unter Verwendung der aufgeführten Quellen und Hilfsmittel angefertigt habe. Alle Stellen, die den benutzten Quellen und Hilfsmitteln unverändert oder inhaltlich entnommen sind, habe ich als solche kenntlich gemacht.

2) Sofern generative KI-Tools verwendet wurden, habe ich Produktnamen, Hersteller, die jeweils verwendete Softwareversion und die jeweiligen Einsatzzwecke (z.B. sprachliche Überprüfung und Verbesserung der Texte, systematische Recherche) benannt. Ich verantworte die Auswahl, die Übernahme und sämtliche Ergebnisse des von mir verwendeten KI-generierten Outputs vollumfänglich selbst.

3) Die Satzung zur Sicherung guter wissenschaftlicher Praxis an der TU Berlin vom 15. Februar 2023[1] habe ich zur Kenntnis genommen.

4) Ich erkläre weiterhin, dass ich die Arbeit in gleicher oder ähnlicher Form noch keiner anderen Prüfungsbehörde vorgelegt habe.

_____

M. Sc.
First name middle name last name
Berlin, 23. Januar 2026

---

[1] https://www.static.tu.berlin/fileadmin/www/10002457/K3-AMBl/Amtsblatt_2023/Amtliches_Mitteilungsblatt_Nr._16_vom_30.05.2023.pdf

English

1) I hereby declare that I have written this thesis without the help of third parties and exclusively using the sources and aids listed. I have marked as such all passages that are taken from the sources and aids used, either unchanged or in terms of content.

2) Where generative AI tools were used, I have stated the product name, manufacturer, the software version used and the respective purposes (e.g. linguistic review and improvement of texts, systematic research). I am fully responsible for the selection, adoption and all results of the AI-generated output I used.

3) I have taken note of the Statutes for Safeguarding Good Scientific Practice at TU Berlin dated February 15, 2023[2].

4) I further declare that I have not yet submitted the work in the same or a similar form to any other examination authority.

M. Sc.
First name middle name last name
Berlin, January 23, 2026

---

[2] https://www.static.tu.berlin/fileadmin/www/10002457/K3-AMBl/Amtsblatt_2023/Amtliches_Mitteilungsblatt_Nr._16_vom_30.05.2023.pdf

TU Berlin | Sekr. KWT 9 | Straße des 17. Juni 135 | 10623 Berlin

Fakultät III Prozesswissenschaften
Institut für Prozess- und Verfahrens-
technik

Fachgebiet Dynamik und Betrieb
technischer Anlagen

**Prof. Dr.-Ing. habil.
Jens-Uwe Repke**

Sekretariat KWT 9
Raum KWT-N 111
Straße des 17. Juni 135
10623 Berlin

Telefon +49 (0)30 314-23893
Telefax +49 (0)30 314-26915
jens-uwe.repke@tu-berlin.de

Unser Zeichen:
KWT 9

Berlin, 21. Oktober 2025

Masterarbeit
für <Herrn/Frau> <Vorname Nachname>
Matr.-Nr.: <123456>

Thema der Arbeit / Thesis topic (bitte klar benennen)

Text der Aufgabenstellung / Task description, including (**bitte ersetzen**)
- What is the challenge? What is the goal of the thesis?
- How shall this goal be achieved in terms of methods, models, experiments, etc.?

Bei der Bearbeitung der Aufgabenstellung sind die fachgebietsinternen Regeln für den Umgang mit generativen KI-Tools[1] zu beachten.

Prof. Dr.-Ing. habil. Jens-Uwe Repke

> Seite 1/1 | Aufgabenstellung Abschlussarbeit

[1] https://www.static.tu.berlin/fileadmin/www/10002163/01_Lehre/Fachgebietsinterne_Vorgaben_zur_Nutzung_von_generativer_KI_ENG.pdf

Danksagung

Ein paar nette Worte / Some nice words...

Zusammenfassung

Deutsch

Dies hier ist ein Blindtext zum Testen von Textausgaben. Wer diesen Text liest, ist selbst schuld. Der Text gibt lediglich den Grauwert der Schrift an. Ist das wirklich so? Ist es gleichgültig, ob ich schreibe: „Dies ist ein Blindtext" oder „Huardest gefburn"? Kjift – mitnichten! Ein Blindtext bietet mir wichtige Informationen. An ihm messe ich die Lesbarkeit einer Schrift, ihre Anmutung, wie harmonisch die Figuren zueinander stehen und prüfe, wie breit oder schmal sie läuft. Ein Blindtext sollte möglichst viele verschiedene Buchstaben enthalten und in der Originalsprache gesetzt sein. Er muss keinen Sinn ergeben, sollte aber lesbar sein. Fremdsprachige Texte wie „Lorem ipsum" dienen nicht dem eigentlichen Zweck, da sie eine falsche Anmutung vermitteln. Dies hier ist ein Blindtext zum Testen von Textausgaben. Wer diesen Text liest, ist selbst schuld. Der Text gibt lediglich den Grauwert der Schrift an. Ist das wirklich so? Ist es gleichgültig, ob ich schreibe: „Dies ist ein Blindtext" oder „Huardest gefburn"? Kjift – mitnichten! Ein Blindtext bietet mir wichtige Informationen. An ihm messe ich die Lesbarkeit einer Schrift, ihre Anmutung, wie harmonisch die Figuren zueinander stehen und prüfe, wie breit oder schmal sie läuft. Ein Blindtext sollte möglichst viele verschiedene Buchstaben enthalten und in der Originalsprache gesetzt sein. Er muss keinen Sinn ergeben, sollte aber lesbar sein. Fremdsprachige Texte wie „Lorem ipsum" dienen nicht dem eigentlichen Zweck, da sie eine falsche Anmutung vermitteln.

Schlüsselwörter: *Schlüsselwort1, Schlüsselwort2, Schlüsselwort3*

English

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language. Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like "Huardest gefburn"? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Keywords: *Keyword1, Keyword2, Keyword3*

Inhaltsverzeichnis

Abbildungsverzeichnis

Tabellenverzeichnis

Algorithmenverzeichnis

Codeverzeichnis

Abkürzungsverzeichnis

If the horizontal space is too small or too large for you abbreviations, change the allocated space by entering the longest abbreviation in the \settowidth{} command in f_Abbreviations.tex.

Numerics

ab   **a**ctive **b**ound

DAE   **D**ifferential-**a**lgebraic **e**quation (system)

Software

SUNDIALS   **Su**ite of **n**onlinear and **di**fferential-**al**gebraic equation **s**olvers

Alternatively, you can only have one list of abbreviations without further classification:

ab   **a**ctive **b**ound

DAE   **D**ifferential-**a**lgebraic **e**quation (system)

SUNDIALS   **Su**ite of **n**onlinear and **di**fferential-**al**gebraic equation **s**olvers

ToDo-Verzeichnis

1 Guidelines

This chapter introduces the guidelines for writing a thesis at the Process Dynamics and Operations Group. It is recommended to use LaTeX as the code of this style guide can directly be used for the thesis. However, a Word version of this template is also available. In the template, the correct fonts, font sizes, citation style, and so forth are already set.

1.1 Most Important Style Specifications for LaTeX and Word

– page format: A4, double page, justification, 11 pt for standard font size;

– line spacing:

    ○ Word: 1.2;

    ○ LaTeX: linespacing is set with the `setspace` package any may not be changed;

– fonts :

    ○ Word: Palatino Linotype (text) and Arial (headings);

    ○ LaTeX: the font types are specified within this template and may not be changed;

– margins:

    ○ Word: 38 mm (top), 45 mm (bottom), 20 mm (inside), 35 mm (outside); binding correction: 20 mm (only possible when double page is selected); exception: front page;

○ LATEX: the given settings for BCOR and DIV may not be changed;

– maximum number of pages (only content, excluding lists of . . . and appendix): 80 pages (bachelor thesis), 100 pages (master thesis);

– the layout of the front page is fixed and must not be changed, neither in LATEX nor in Word;

– of course, loading additional packages in LATEX for functionality is fine.

Attention: If these specifications are (partially) ignored, it will have an impact on the evaluation.

1.2 First Steps

1) **carefully read this whole chapter.** It might look like there is a lot to read but you will get additional information on how to use the template, what additional software is out there (especially for drawing figures), and how to avoid issues with the template.

2) install LATEX. On Windows, MikTEX[1] or TEXLive[2] are suitable distributions. MacTEX[3] or TEXShop[4] can be used on a Mac. On Linux, you typically also install TEXLive[5]; make sure to install an up-to-date version of TEXLive on a Linux machine. This template expects a TEXLive distribution ≥ 2019. It is not tested with older versions anymore.

3) install a suitable LATEX editor. We recommend Texmaker[6], which is available for all operating systems. An extensive list of editors is available on Wikipedia[7].

---

[1]https://miktex.org/, February 2019
[2]https://tug.org/texlive/windows.html, February 2019
[3]http://www.tug.org/mactex/, February 2019
[4]https://pages.uoregon.edu/koch/texshop/, February 2019
[5]https://tug.org/texlive/quickinstall.html, February 2019
[6]http://www.xm1math.net/texmaker/, February 2019
[7]https://en.wikipedia.org/wiki/Comparison_of_TeX_editors, February 2019

4) install a suitable program for your literature. We recommend Jabref[8]. It is a Java-based, platform-independent program that generates appropriate `.bib` files for LATEX. A short introduction to Jabref is given in Abschn. 1.10.7.

5) set the language of the document in the `a_Packages.tex` file with the `babel` package. You will notice that this text is written in English while certain headings are in German. This is because the `babel` package is currently loaded with `ngerman` as default language (see Abschn. 1.7).

6) change the necessary entries in `b_Meta.tex` (e.g., your name, matriculation number, etc.), set the right value of the `isDiss` variable and the `isMT` variable (if it is a thesis) in this file

7) check whether `biber` and `makeindex` were set up correctly. Detailed information on this matter can be found in Abschn. 1.8.1

8) check whether you can compile this document without errors (see Abschn. 1.8.2). This should always be the case as long as all necessary packages are installed. This template was successfully compiled with the TEXLive version given in the ReadMe of the git project (older LATEX distributions potentially contain older package version and are thus not supported anymore). **Some problems appeared when users did not have the newest versions of the used packages in this template. If you run into trouble, please update all your packages.**[9] See some more instructions for TEXLive and MiKTEX in Abschn. 1.8.3

9) remove the „Guidelines" chapter from this document by deleting it and removing it from the `0_Text.tex` file in the folder 03_Content

10) add your own `.bib` file for your references or use the present one (it is recommended to simply use the given one)

11) start writing your thesis – good luck!

---

[8]http://www.jabref.org/, February 2019
[9]https://tex.stackexchange.com/questions/55437/how-do-i-update-my-tex-distribution, January 2019

12) note that not all of the shown items in the following sections *must* be part of your thesis. If a certain aspect does not apply to you, for example a List of Algorithms, just remove it from the thesis.

1.3 General Information

1) the current „Prüfungsordnung" overrides the following rules if they contradict the „Prüfungsordnung".

2) the thesis must be written in German or English.

3) a thesis is a scientific-technical documentation that must satisfy requirements regarding structure and form. It should be precisely formulated and well-written, i.e., no orthographic or grammar mistakes, etc.

4) the thesis should be logically structured.

5) the thesis should present its scientific-technical content while remaining comprehensible. Germans tend to formulate complex phrases with many sub-clauses. This should be avoided. Hence, the author should repeatedly put him- or herself into the position of the reader and evaluate the thesis in this regard.

6) the Figure, i.e., picture, diagram, photo, is preferred to long explanations.

7) results must be tractable. Hence, the applied methods, assumptions, boundary conditions, experiments, and computer codes must be pointed out and explained in sufficient detail.

8) calculations should be documented. This is of course difficult for large models. In this case, the code should be attached to the printed or digital appendix.

9) the thesis should focus on the central themes and aspects. Other information should be referenced appropriately, but does not have to be repeated extensively.

1.4 Form

1) physical units must always be given and are preferably stated in SI units. Units must not be stated in brackets:

   – *WRONG:* Pressure P [Pa];

   – *RIGHT:* Pressure P in Pa.

   The only correct use of square brackets is shown here for the voltage:
   [U] = V, i.e., the unit of the voltage is Volt.

2) a List of Symbols and a List of Abbreviations must be included. This is done with the `nomencl` and the `acro` package in this template. In addition, symbols should be explained in the text after their first appearance. A List of Algorithms or other lists can be added if necessary.

3) figures, tables, and equations must be numerated and referenced in the text. This is automatically done using the `caption` package (see Abschn. 1.10) and the `\autoref` command (Abschn. 1.10.10). For example, a Figure is named Figure chapter.Num (Figure 2.1). The numeration is done automatically in this template. In addition, figures and tables must also be explained and discussed in the text.

4) figures should be chosen to support comprehension. In particular, the most important details and relevant labels must be *readable*.

5) extensive tables or figures that are repeatedly referenced in the text should be put in the appendix.

6) information or data not generated by the author must always be referenced. Citations/references are used to

   – document and justify one's own statements,

   – differ between one's own statements and those made by others,

   – help the reader to assess the origin of a statement

All information not generated by the author must be marked with a short reference, which is accompanied by the extensive reference in the bibliography. It is not important if this information appears directly or indirectly in the text. We either use the authoryear or the numerical short citation.

The most important rule is: The references must be complete and follow a consistent format. This is more important than following a specific citation style. If possible, the DOI/ISBN of an article/book should be part of the citation. This is also included automatically in this template. The commands and some examples are shown in Abschn. 1.10.7.

1.5 Appearence

1) the format of the page numbering and the appendix chapters is already specified and may not be changed.

2) there is a maximum of four indenture levels (chapter, section, subsection, paragraph) in the text and a maximum of three levels in the table of contents. The subsubsection should not be used as four numbers are bad style for structuring a text.

3) important aspects can be emphasized with *italics*, **bold writing**, or using the *emphasize command* `\emph`. Underlining words should be avoided.

4) paragraphs should not start in the last two lines of a page („Schusterjunge" or orphen) or end in the first two lines of a page („Hurenkind" or widow). This is automatically achieved with the `nowidow` package in this template.

1.6 Template Structure

This template contains several features given in Tab. 1.1. The structure of the template is described in Tab. 1.2. Questions, problems, or additional feature requests can be posted on the gitlab webpage of this template.[10]

---

[10]https://git.tu-berlin.de/dbta/templates/Thesis_template/issues, February 2021

Tab. 1.1: Template features.

No.	Feature
1)	Valid for theses or dissertations
2)	Usable in German or English depending on the `babel` settings
3)	Ready for use in online editors, such as Overleaf (see Abschn. 1.9.2)
4)	List of Algorithms using the `algorithm2e` package and KOMA script
5)	List of Codes using the `listings` package and KOMA script
6)	List of Symbols (Latin, Greek, etc.) using the `nomencl` package
7)	List of Abbreviations using the `acro` package
8)	List of References using the `biblatex` package and `biber`
10)	Index with the `imakeidx` package
11)	ToDos and missing figures using the `todonotes` package
12)	Extra features, such as PDF/A compatibility or automatic indenting of TeX code
13)	various templates for typical elements of a thesis (figure, table, . . .)

Tab. 1.2: File structure of template. Folder names are printed bold.

File name (without extension)	Description
`main`	Must be compiled
	Can be chosen as master document
00_Arara_and_Latexindent	
`localSettings`	local settings for automatic indenting
	More information in Abschn. 1.9.3 and Anhang C
01_Document_administration	
`a_Packages`	All loaded packages
	Sorted based on application
	All packages are stated in Tab. D.1

Tab. 1.2 (continued).

File name (without extension)	Description
`b_Meta`	Meta information regarding author, title, keywords, etc.
	Boolean variable to select whether it is a dissertation or a bachelor/master thesis
	Boolean variable to select whether it is a master or a bachelor thesis
	Boolean variable to select whether the thesis contains an embargo notice due to a confidentiality agreement; also allows you to set the company's name
	Loads the `pdfx` package to ensure PDF/A compatibility and to set the metadata of the PDF
`c_Commands`	Commands regarding format and look of the document
`d_Nomenclature Commands`	Structure of the List of Symbols
	Optional argument defines the class of a symbol (Latin, Greek, …)
	`makeindex` is used for the generation of the List of Symbols. A short instruction how to run `makeindex` correctly in Texmaker is given in Abschn. 1.8.1.
`e_Abbreviation Definitions`	Definitions of abbreviations in the text
	Abbreviations can be subdivided into classes
	More information can be found in the `acro` documentation
`f_CodeLanguage Specifications`	Definition of keyword set and comment commands for a certain programming language
	To apprehend the code with your thesis, either copy the code to an `lstlistings` environment (see examples in Anhang A) or directly include your files
02_Prematter	
`a_Cover`	Cover page. Depending on the values of `isDiss` set in `b_Meta.tex`, the correct cover is printed. The covers for both thesis and dissertation are shown in Abb. 1.1.
`b_Declaration`	Declaration that thesis was written honestly
`c_Dedication`	Dedication for thesis dissertation
	Only included if `isDiss` is true

Tab. 1.2 (continued).

File name (without extension)	Description
`c_Task`	Scan of the task description
	Only included if `isDiss` is false
`d_Acknowledgem ents`	Thanks to important people
`e_Abstract`	Summary in German and English
`f_Publications`	Publications in preparation of the dissertation
	Only included if `isDiss` is true
`g_Nomenclature`	Definitions of symbols
`h_Abbreviation s.tex`	Inclusion of abbreviations
03_Content	
`0_Text`	Loads all chapters
`X_iii`	Single chapter
04_Appendix	
`0_Appendix`	Loads all appendix chapters
`X_Appendix`	Xth appendix
05_Literature_and_Index	
`Bibliography`	Literature database
`myindexstyle`	Style for the Index (see Abschn. 1.9.4)

1.6.1 Figures

This folder is added to the `graphicspath` in the `c_Commands.tex` file and contains all figures in this template. Being added to the `graphicspath` means that you may include figures without having to specify a path. However, it might become a little confusing if all your figures are placed within one folder. Luckily, several different folders can be added to the `graphicspath`.

(a) Cover in diss. mode (`isDiss=true`).　　**(b)** Cover in thesis mode (`isDiss=false`).

Abb. 1.1: Covers of this template. These were slightly adapted over the years with newer versions.

1.7 Language: English or German?

The language of this document is set with the `babel` package. The order of the loaded languages determines the default language. Usually, `ngerman` is default (and hence the *second*) language. The `babel` package automatically sets the localized names for Tables and Figures, provides the correct hyphenation, and does more language-related things. In case the thesis is written in English, the order of the languages when loading the `babel` package must be changed. If the language is English, the output decimal marker for SI units (`siunitx` package) is also automatically changed to a period.

1.8 LᴬTEX Editor Settings and Maintenance

1.8.1 `Biber` and `Makeindex`

– command line for setting up `biber` in Texmaker (see Abb. 1.2):

1) Windows:
   ```
   "C:/path_to/biber.exe" %
   ```
   in TEXLive, `biber` is located in `bin/win32`

2) Linux:
   ```
   "/usr/path_to/biber" %
   ```

3) MacOS:
   ```
   "/usr/path_to/biber" %.bcf
   ```

– command line for setting up `makeindex` in Texmaker (see Abb. 1.2):

1) Windows:
   ```
   "C:/path_to/makeindex.exe" %.nlo -s nomencl.ist -o %.nls
   ```
   in TEXLive, `makeindex` is located in `bin/win32`

2) Linux:
   ```
   "/usr/path_to/makeindex" %.nlo -s nomencl.ist -o %.nls
   ```

3) MacOS:
   ```
   "/usr/path_to/makeindex" %.nlo -s nomencl.ist -o %.nls
   ```

Note that `path_to` depends on your system. If the LATEX distribution is in your system path, simply writing `biber` or `makeindex` (without extension) instead of the whole path should suffice. If you use another editor than Texmaker, check your editor's documentation to find out how to run `biber` and `makeindex` in this software. However, the paths/commands should be similar to those above.
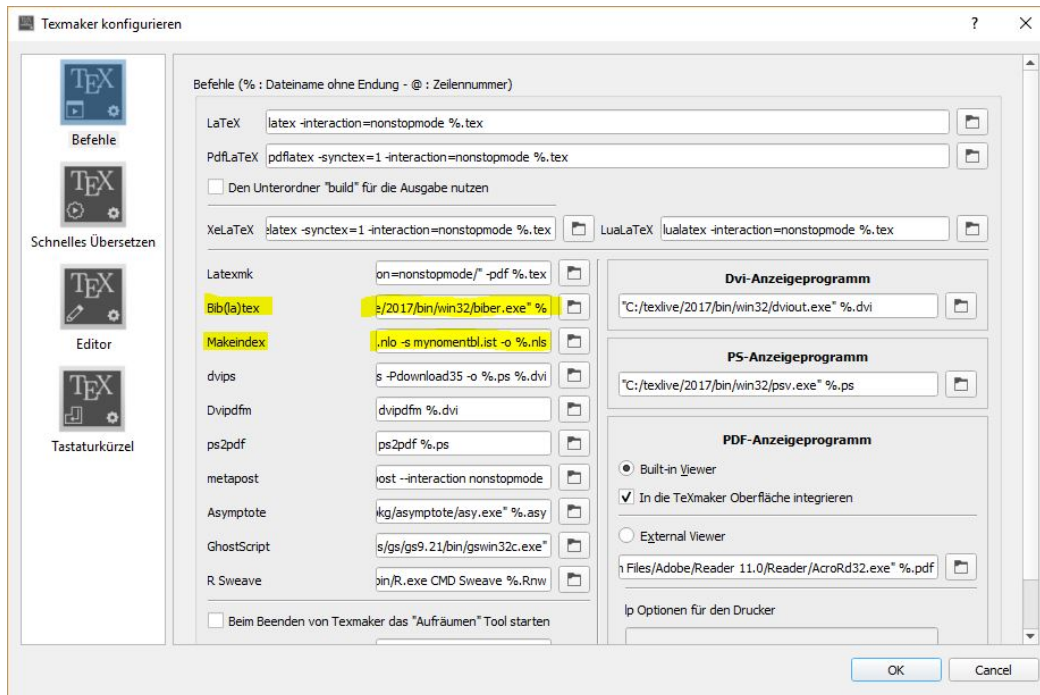
Abb. 1.2: Setting up `biber` and `makeindex` in Texmaker. Zoom in if you need more details.

1.8.2 Compiling the Document

The following commands/scripts must be run to compile the document completely:

1) PDFLATEX: This generates a first PDF. At this point, the List of References and the List of Symbols are missing.

2) `biber`: Run `biber` (Texmaker standard short key: F11) after you set it up according to Abschn. 1.8.1. This creates the necessary temporary reference file.

3) `makeindex`: Run `makeindex` (Texmaker standard short key: F12) after you set it up according to Abschn. 1.8.1. This creates the necessary temporary nomenclature file.

4) PDFLATEX (three times): The first run should already generate the List of References and the List of Symbols. The second run should update all citations

etc. in the PDF. Sometimes, a third run is necessary if some references within the text have changed again. In this case, a third run is necessary. Check the output of Texmaker.

1.8.3 Updating Packages in T_EXLive and MiKT_EX

As stated above, compilation problems appeared with this template when old versions of the packages were used. Unfortunately, there does not seem to be a possibility to automatically check for updates of packages when they are included in a LATEX document.
In case you have issues when compiling this document, start with updating all your packages. The following instructions are valid for a Windows operating system.

T_EXLive manages the packages tlshell. Its GUI is located in `texlive/year/b in/win32`. In this folder, you find a file called `tlshell.exe`. Use this program to update your packages.

MiKT_EX manages the packages in the MiKT_EX console. Use this application to update your packages.

Similar applications are available on all other operating systems. Restart your LATEX editor after updating all packages and see whether you can compile this template without errors. If your problem persists, please add an issue on the gitlab webpage of this template.[11]

1.9 Extra Features

The following sections introduce a few extra features. None of them are necessary for a thesis (except for PDF/A for a dissertation), but they might be of use for some people.

---

[11] https://git.tu-berlin.de/dbta/templates/Thesis_template/issues, February 2021

1.9.1 Compatibility with PDF/A

Dissertations are stored as PDF/A at the university library. To ensure compatibility of this template with PDF/A, the `pdfx` package is used with the option `a-2b`. The compiled PDF was successfully validated with Callas[12], as recommended by the university library[13]. Note that contrary to the descriptions given in the linked document in Fußnote 13, a specific color profile is *not* necessary if you use an up-to-date version of the `pdfx` package as it automatically includes a free color profile. Check the documentation of the `pdfx` package to find how to include other color profiles. Normally, the default should however suffice. The `pdfx` package also loads the `hyperref` package. **Note that the `pdfx` package cannot ensure that all your included PDFs fulfill the PDF/A standard. Hence, check your PDF for PDF/A compatibility whenever you included external files.**

1.9.2 Support for Overleaf or other online editors

This template is compatible with Overleaf[14], an online editor for LaTeX documents. If you would like to write in such an online environment, upload the content of the subfolder `LaTeX_template_thesis` to an empty project and compile it online. This way, you do not have to install any LaTeX distribution locally. **Note that this is not advised if you have sensitive data, for example from a company. In this case, your data should remain on your or your company's computer!**

1.9.3 Automatic Indenting of .tex Files

Indenting *can* be used for structuring one's document, e.g., by indenting everything within an `equation` environment, but is certainly *not* a must-have for a thesis. If you do not need automatic indenting, you can skip this section.
Unfortunately, LaTeX does not offer automatic indenting as do, for example, Matlab

---

[12]https://conversion.ub.tu-berlin.de/, December 2018
[13]https://www.static.tu.berlin/fileadmin/www/10002444/Dokumente/Forschen_Publizieren/Dissertationsstelle/pdf-guide-202211-de.pdf, October 2025
[14]https://de.overleaf.com/, January 2019

or Python. However, the perl script-based `latexindent`[15] can be used for automatic indenting of the source code. This executable is part of every LATEX distribution. There are two ways of using `latexindent`: directly running `latexindent` or calling it via `arara`[16]. The arara software is also part of every LATEX distribution and can be used for TEX automation.[17] The first option is described here for a Windows operating system (the instructions for Linux and Mac should be similar; only the file extension .exe is propably different). With this option, it is only possible to indent one file at a time (the file that is currently open in Texmaker). The second option can automatically indent all files in the document and is described in Anhang C.

To get automatic indenting, add a user command in Texmaker (User → User Commands → Edit User Commands). You might call one menu item `latexindent`. The command is shown in Code 1.1. This means that `latexindent` is executed with writing rights (-w) on the current `.tex` file with local settings (-l) in the given path. These local settings are the only issue, because the absolute path can of course change if you move your folder. However, the relative path would always change depending on which file you actually want to indent.

The local settings are important as they specify that only one backup is created. For more information, please refer to the documentation of `latexindent`. You can then execute your new user command in Texmaker with the opened file in question. Afterwards, update your file by clicking on File → Reload document from file. The result is shown in Abb. 1.3. **Note that automatic indenting might not be available for online editors.**

```
"C:/path_to_texlive/year/bin/win32/latexindent.exe" -w %.tex -l="
    absolute_path_to_thesis_template/Thesis_template/
    LaTeX_template_thesis/00_Arara_and_Latexindent/localSettings.yaml"
```

Code 1.1: Setting up `latexindent` in Texmaker.
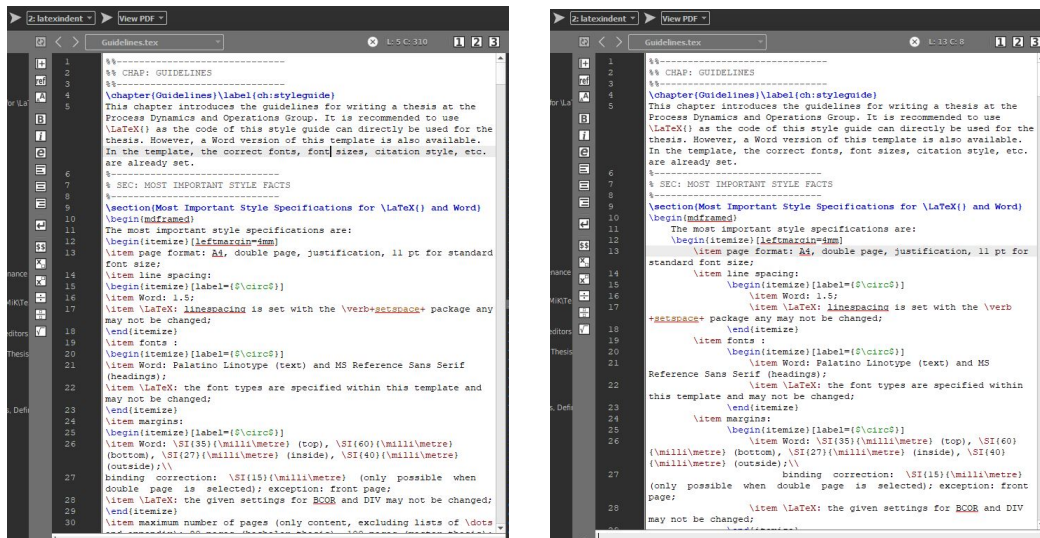
1.9.4 Index

If you want to give the reader the possibility to quickly scan your document for the interesting keywords, you can generate an Index at the end of your thesis. This

---

[15] https://github.com/cmhughes/latexindent.pl, February 2019
[16] https://tex.stackexchange.com/questions/126241/autoindent-in-texmaker, January 2019
[17] https://github.com/cereda/arara, February 2019

(a) Before.

(b) After.

Abb. 1.3: Before (left) and after (right) automatic indenting with `latexindent`.

is certainly not necessary for a bachelor or master thesis, but can be used for a dissertation. In this template, the `imakeidx` package is used. This automatically executes `makeindex` during compilation. If you do not want an Index, remove the `\makeindex` command from the `c_Commands.tex` file and the `\printindex` command from the `main.tex` file.

The Index works as follows: You simply write your text and add the keyword to the index with the `\index{}` command. You can combine keywords to categories, e.g., Thermodynamics might be one keyword. Now you can add other keywords to this category with `\index{keyword!subkeyword}`. This could be equations of state or activity models. The results are shown in the Index on page 69.

1.9.5 Software for Vector Graphics

Figures are an important part of every thesis. Normally, these figures are generated by the author, who is hence responsible for their quality. Vector graphics are generally preferred to raster graphics (JPG, PNG,
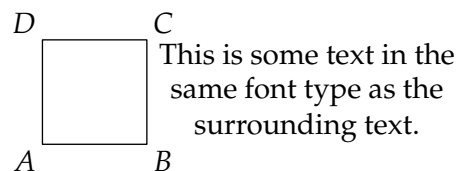

Abb. 1.4: Image generated with Asymptote.

. . .) as their quality does not depend on the
resolution. There are a few programs for ge-
nerating figures within LATEX, which are listed in the following. Plotting within
LATEX has a few advantages, for example: the figure always has the same font type
as the text, and global settings can be applied to all figures within one document.
Typically, one can either compile all figures whenever PDFLATEX is executed, or only
compile the changed figures, or generate the PDFs in a separate file and include the
PDF in the document.

Asymptote is a powerful vector graphics program[18]. It can be made visible to
all LATEX distributions with a package[19]. Asymptote can directly generate a
PDF output. An example of an image generated with Asymptote is shown in
Abb. 1.4. In this case, the image was generated externally and is now included
as a PDF. The code of this image is located in the `Examples` folder of this
template.

TikZ is another vector graphics tool[20]. It is also available for all LATEX distributi-
ons.[21] Asymptote and TikZ are similar as all images are produced based on
commands (similar to LATEX code). Choose between these two programs based
on your own preferences.

In TikZ, it is recommended to externalize your figure, i.e., they are only
redrawn if something was changed. In this case, add the lines in Code 1.2
below the section on makeindex in the `c_Commands.tex` file to make sure
everything works smoothly. First of all, the external library is loaded, secondly,
externalization is started. Importantly, shell escape must be enabled here.
In addition, the `\includepdf` command is excluded from externalization.
Finally, the `\todo` command is redefined so it also disables externalization
locally. More on these issues can be found here[22,23]. **You need to create
the folder `TikZ` if you use this prefix**.

---

[18]http://asymptote.sourceforge.net/, March 2019

[19]https://ctan.org/pkg/asymptote, March 2019

[20]https://sourceforge.net/projects/pgf/, March 2019

[21]https://www.ctan.org/pkg/pgf, March 2019

[22]https://tex.stackexchange.com/questions/135504/includepdf-causes-an-error-message-from-pgfplots-externalization, August 2019

[23]https://tex.stackexchange.com/questions/42486/todonotes-and-tikzexternalize, August 2019

PSTricks was designed for PostScript vector graphics[24] and is available for all LaTeX distributions.[25] Due to its PostScript origin, it cannot directly be used with PDFLaTeX. If you want to compile with PDFLaTeX, the best solution is using the package `auto-pst-pdf`[26].

Inkscape is a graphics tool, which is not used with commands (as are the others), but which is similar to Visio or Powerpoint in its use.[27] However, Inkscape exports an additional file containing the LaTeX specifiations for an image. Hence, the text of an exported image will adapt to the font size and type of the LaTeX document.

Draw.io is an open source program for drawing flowcharts or pipe & instrumentation diagrams.[28] It contains many more shapes for process engineering than a standard version of Microsoft Visio. Figures can be exported as PDF and further, for example, further processed in Inkscape. Draw.io is available as browser application or can be installed on a computer.

mathcha.io is an online LaTeX-based editor and may be used for generating small sketches and drawing.[29] Designed graphs can be exported to TikZ or as images.

```
\usetikzlibrary{external}
\tikzexternalize[prefix=Tikz/,shell escape=-enable-write18,optimize
    command away=\includepdf]
\tikzset{external/system call={pdflatex \tikzexternalcheckshellescape -
    halt-on-error -interaction=batchmode -jobname "\image" "\texsource"}}
\makeatletter
\renewcommand{\todo}[2][]{\tikzexternaldisable\@todo[#1]{#2}\
    tikzexternalenable}
\makeatother
```

Code 1.2: Command lines for externalization in TikZ.

---

[24]http://www.tug.org/PSTricks/main.cgi/, March 2019
[25]https://www.ctan.org/pkg/pstricks-base, March 2019
[26]https://ctan.org/pkg/auto-pst-pdf?lang=de, March 2018
[27]https://inkscape.org/de/, March 2019
[28]www.draw.io, June 2020
[29]https://www.mathcha.io, August 2020

1.10 Templates for Typical Elements of a Thesis

This section introduces templates for the typical elements of a thesis, such as tables, figures, equations, etc.

1.10.1 Tables

A template for a Table is given in Tab. 1.4. Tabelle 1.4 should not be abbreviated at the beginning of a sentence. A common issue in LaTeX are footnotes within tables. However, there is the `threeparttable` package to deal with this. In such a `threeparttable` environment, annotations can be easily added (Tab. 1.5). Normal tables in LaTeX cannot go over several pages. For longer tables, see the `longtable` package in Anhang B. This template also loads the `threeparttablex` package, which extends the annotation feature to the `longtable` environment. The `wrapfig` package can also be used for wrapped tables as shown in Tab. 1.3. Again, make sure that the Table is small enough.

Tab. 1.3: A wrapped table.

Variable	Mean	Std. Dev.
a	4	$\pm 0{,}1$

Tab. 1.4: This is the caption of the Table in the text. Is is placed *above* the table. It can be longer and contain additional information. Vertical lines should be avoided in tables. A full stop is automatically added after the last sign.

Entry 1 Unit 1	Entry 2 Unit 2	Entry 3 Unit 3	Unit column Some text	*Italics* *Some text*
1	2	3	J	*bla*
4	5	6	$\mathrm{Pa\,m^{-2}}$	*bla bla*

Tab. 1.5: Exemplary table with an annotation.

Variable	Mean	Std. Dev.
a	4	$\pm 0{,}1^{*}$

[*] This standard deviation is only true if I measured correctly

1.10.2 Figures

A template for a Figure is given in Abb. 1.5. Abbildung 1.5 should not be abbreviated at the beginning of a sentence. Note that the often used `\ref` command is not used here. Instead, Abschn. 1.10.10 introduces the `\autoref` command.

Abb. 1.5: This is the caption of the Figure in the text. Is is placed *below* the Figure. It can be longer here and contain additional information, such as references or keys for the graphs. Note that one-line captions are justified. A full stop is automatically added after the last sign.

Although it is not seen on a regular basis in theses or dissertations, a Figure may also be surrounded by text. The `wrapfig` package is used for this purpose. It depends on the Figure's size if this is a good or a bad idea. Make sure that readability of the Figure is still given. An example is given in Abb. 1.6. Another possibility is putting descriptive text in an otherwise raw figure. This is illustrated in Abb. 1.7. The `overpic` package provides the necessary environment of

Abb. 1.6: A wrapped figure.

the same title and the `\put` command to add arbitrary text. If the environment is loaded with the additional options `tics=10,` `grid`, a grid with ten tics is drawn to ease the positioning of the text. Thus, the inserted text automatically uses the same font type as the surrounding text.
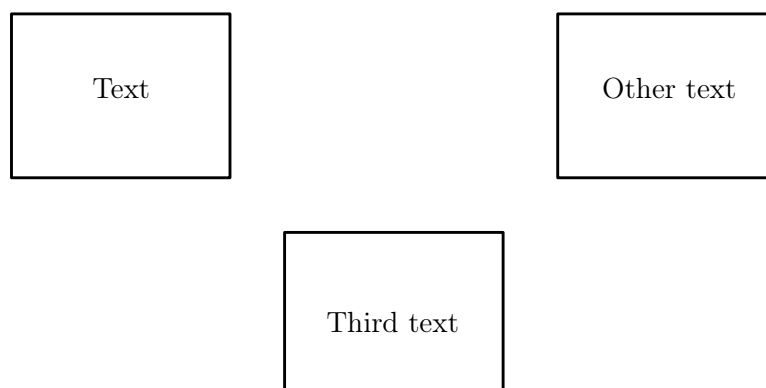
Text

Other text

Third text

Abb. 1.7: Example of overpic environment.

1.10.3 Numbers and Units

Numbers and units are very important, and there are some rules when typesetting them. For example, units are never written in italics. They should also have the right space between them. For this purpose, the `siunitx` package is suggested.

– numbers (`\num{number}`): $3{,}141\,59$

– exponentials (`\num{numbere6}`): $1{,}3 \cdot 10^6$

– units (`\unit{\unit}`): $\mathrm{J\,mol^{-1}\,K^{-1}}$

– numbers+units (`\qty{number}{\unit}`): $8{,}314\,\mathrm{J\,mol^{-1}\,K^{-1}}$

– ranges (`\qtyrange{number1}{number2}{\unit}`): 4 bis $10\,\mathrm{K}$.

– uncertainty (`\num{number(uncertainty)}`): $410{,}33 \pm 0{,}55$

– uncertainty with units (`\unit{number(uncertainty)}{\unit}`): $(410{,}33 \pm 0{,}55)\,\mathrm{J}$

– own units can also be defined as has been done for $\mathrm{kJ\,mol^{-1}}$ and $\mathrm{kJ\,mol^{-1}\,K^{-1}}$

1.10.4 Equations

An exemplary Equation is given in Gl. (1.1). Gleichung (1.1) should not be abbreviated at the beginning of a sentence. The efficient used commands to generate the partial derivative were made with the `xparse` package.

$$\left(\frac{\partial^2 f}{\partial x^2}\right) = \left[\frac{\partial^4 g}{\partial x^4}\right]. \tag{1.1}$$

For important equations, you might want to use a box:

$$\boxed{E = mc^2} \tag{1.2}$$

1.10.5 Optimization problems

In many applications, optimization problems must be stated in theses and dissertations. This can be realized with the `optidef` package:

$$\begin{aligned} \min_{\omega} \quad & f(\omega) \\ \text{s.t.} \quad & 0 \geq g(\omega) \quad \text{(Constraints)}, \\ & \omega \in \Omega. \end{aligned} \tag{1.3}$$

1.10.6 Acronyms and Abbreviations

Abbreviations are defined in `e_AbbreviationDefinitions.tex` using the `acro` package. New abbreviations must typically be explained at their first appearance in the text. The `\ac` command uses the defined acronyms (see List of Abbreviations) for doing that. For example, the **Su**ite of **n**onlinear and **di**fferential-**al**gebraic equation **s**olvers (SUNDIALS) is explained here, but not afterwards because SUNDIALS was already defined. It seems to be more to write, but thus you make sure that an abbreviations is explained only at its first appearance ... even if you change your text completely. In addition, you link your abbreviations to the List of Abbreviations. The `acro` package also contains specific commands for the plural of the long and the short form of the abbreviations; check the documentation for

more information. Moreover, the abbreviations are automatically added to the Index. Note that expressions, such as e.g., or i.e., *should not* be added to the List of Abbreviations.

You can define several tags with the `acro` package as has here been done for ***D**ifferential-**a**lgebraic **e**quation (system)* (DAE) or ***a**ctive **b**ound* (ab).

1.10.7 References

LaTeX – or more precisely `biber` – includes literature if it is stored as `.bib` file. It is however not recommended to manually write in `.bib` files, but one should use a program for administrating literature. Examples of such programs are Mendeley or Jabref (Abb. 1.8). In Jabref, one can add literature via the DOI or the ISBN. Furthermore, it offers templates for all standard document classes, such as articles, books, online references, and more.

In the following, a few examples of the authoryear short reference are stated. For more information, the reader is referred to the documentation of the `biblatex` package. `Biblatex` and `biber` are used because they are compatible with UTF8. Hence, Umlaute, such as ä, do not have to be rewritten as was the case in bibtex. In addition, `biblatex` supports editing of the citation style via TeX and LaTeX commands. Hence, the tedious editing of bibliography styles (`.bst` files), which were used with bibtex, is not necessary anymore.

Note that references to books should contain the page number.

- book: (**Coker2007**), **Coker2007**

- article: (**Abrams1975**), **Abrams1975**

- conference paper: (**Penteado2018**), **Penteado2018**

- online: (**benzene_nist2017**), **benzene_nist2017**

- dissertation: (**Cuda2012**), **Cuda2012**

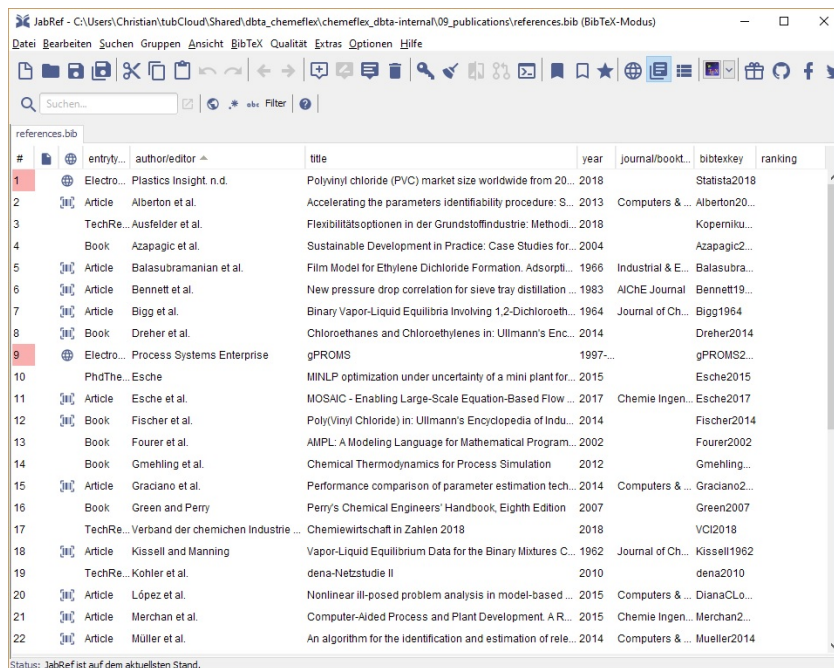- bachelor/master thesis: (**Hoffmann2015**), **Hoffmann2015**

These commands are used as

- `\textcite{bibtexkey}`:
  „**Abrams1975** stated that thermodynamics are great."

- `\parencite{bibtexkey}`:
  „Thermodynamics are great (**Abrams1975**)."

Another helpful method are shorthands. These can be used when the original author or institution would lead to a very long reference in the text, e.g., for norms. In the following, the normal reference and the shorthand citation are shown. The `\textcite{}` has been redefined to introduce the shorthand:

- **DIN1319_4**

- **DIN1319_4**

Abb. 1.8: Jabref.

1.10.8 Chemistry and Chemical Reactions

Sometimes, it is necessary to state chemical reactions or molecules. For this purpose, the `chemfig` and the `chemformula` package, which is loaded as part of the
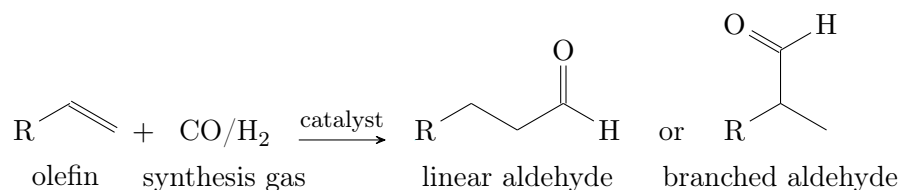
Abb. 1.9: Hydroformylation reaction scheme to demonstrate the two chemistry packages.

`chemmacros` package, are used as shown in Abb. 1.9. Molecular formulas should not be written in math mode, but can be typeset with the `\ch{}` command, e.g., H_2O. Note that chemical formulae, e.g., CO_2 for carbon dioxide, *should not* be added to the List of Symbols or the List of Abbreviations, while abbreviations, e.g., MEA for monoethanolamine, *should* be added to the List of Abbreviations. Greek letters in chemicals are not typeset in italics, therefore the `upgreek` package is loaded to typeset γ-Aluminium instead of *γ*-Aluminium.

1.10.9 Theorems, Lemmas, Proofs, Remarks, Definitions, and Algorithms

All of these items are introduced in the following. Note that frames and their colors are arbitrary. You might want to change the color or the linewidth. You can do this in the `c_Commands.tex` file.

Theorems: Theorems can be defined using the `amsthm` package in combination with the `mdframed` package for a possible frame. An exemplary Theorem is given in Satz 1.1.

> **Satz 1.1 (What is theoremed):** *Let f be a function whose derivative exists in every point, then f is a continuous function.*

Lemmas: Lemmas can be defined using the `amsthm` package in combination with the `mdframed` package for a possible frame. An exemplary Lemma is given in Satz 1.2.

> **Hilfssatz 1.2 (What needs to be lemma'd):** *Given two line segments whose lengths are a and b, respectively, there is a real number r such that $b = ra$.*

Proofs: Proofs can be defined using the `amsthm` package. They are typically not numerated as they follow a certain Theorem or Lemma.

What needs to be proven. To prove it by contradiction, try and assume that the statement is false, proceed from there, and at some point, you will arrive at a contradiction. $\qquad\square$

Remarks: Remarks can be defined using the `amsthm` package in combination with the `mdframed` package for a possible frame. An exemplary Remark is given in Satz 1.3.

> **Bemerkung 1.3 (What the remarker remarks):** *This statement is true, I guess.*

Definitions: Definitions can be defined using the `amsthm` package in combination with the `mdframed` package for a possible frame. An exemplary Definition is given in Satz 1.4. Gleichung (1.4) can also be referenced.

> **Definition 1.4 (What the definition defines):** *This is a definition. It defines itself.*
> $$c = \infty \qquad (1.4)$$

Algorithms: Algorithms can be displayed using the `algorithm2e` package. An example is shown in Alg. 1.1.

Algorithmus 1.1: How to write algorithms

Data: this text
Result: how to write algorithm
initialization;
while *not at end of this document* **do**
    read current;
    if *understand* **then**
        go to next section;
        current section becomes this one;
    else
        go back to the beginning of current section;
    end
end

1.10.10 Autorefs

The `hyperref` package also supplies an `\autoref` command, which is linked to babel. In this case, Fig. or Tab. are localized and you do not have to remember whether you used Fig. or Figure or something else in the text. As stated above, the long version of an item should be used at the beginning of a sentence (the `\Autoref{label}` command was defined for this purpose). Some short forms are equal to their long forms as there is not really a good abbreviation:

1) German ...

    – ..., siehe Kap. 1. Kapitel 1 zeigt, dass ...

    – ..., siehe Abschn. 1.10. Abschnitt 1.10 zeigt, dass ...

    – ..., siehe Abschn. 1.8.1. Abschnitt 1.8.1 zeigt, dass ...

    – ..., siehe Abb. 1.5. Abbildung 1.5 zeigt, dass ...

    – ..., siehe Tab. 1.4. Tabelle 1.4 zeigt, dass ...

    – ..., siehe Gl. (1.1). Gleichung (1.1) zeigt, dass ...

    – ..., siehe Satz 1.1. Satz 1.1 zeigt, dass ...

- ..., siehe Satz 1.2. Satz 1.2 zeigt, dass ...

- ..., siehe Satz 1.3. Satz 1.3 zeigt, dass ...

- ..., siehe Satz 1.4. Satz 1.4 zeigt, dass ...

- ..., siehe Alg. 1.1. Algorithmus 1.1 zeigt, dass ...

2) English ...

- ..., see Chap. 1. Chapter 1 shows that ...

- ..., see Sec. 1.10. Section 1.10 shows that ...

- ..., see Sec. 1.8.1. Section 1.8.1 shows that ...

- ..., see Fig. 1.5. Figure 1.5 shows that ...

- ..., see Tab. 1.4. Table 1.4 shows that ...

- ..., see Eq. (1.1). Equation (1.1) shows that ...

- ..., see Theorem 1.1. Theorem 1.1 shows that ...

- ..., see Theorem 1.2. Theorem 1.2 shows that ...

- ..., see Theorem 1.3. Theorem 1.3 shows that ...

- ..., see Theorem 1.4. Theorem 1.4 shows that ...

- ..., see Alg. 1.1. Algorithm 1.1 shows that ...

1.10.11 ToDos

change that asap!

change that later at some point

In your thesis, you always have parts where you will have to do something more later on. You can mark these sections with the `\todo[option]{text}` command. Something that should be done later might be green. You can also include a „missing figure" if you currently do not have it. When you do not have any more ToDos, remove the List of ToDos from the `main.tex`.

Fehlende Abbildung

I want to add the results of my current experiment here

2 Introduction

Some introducing words ...

2.1 Motivation

Give a general overview on the subject of this thesis! In which context shall the content of this thesis be seen?

2.2 Research Goal

What questions shall be investigated and answered in this thesis? What is the scope of this work?

2.3 Outline of Work

What is the structure of this thesis?

3 Theoretical Background

In this chapter, all fundamentals that are necessary to understand this work are introduced.

4 Étale Morphisms

Étalé morphisms are the central class of morphisms in this thesis, since they form the basic building blocks of the étale Grothendieck topology on schemes. Before we dive deeper into general schemes, we first recall the relevant notions for rings and affine schemes.

Definition 4.1 (Thickening): *(Görtz, Wedhorn, 2023, (Definition 18.1), p. 32) Let $\iota : Y \hookrightarrow X$ be a closed immersion of a quasi-coherent ideal $\mathscr{I} \subset \mathscr{O}_X$. We call ι a thickening, iff $\mathscr{I}$ is locally nilpotent, i.e. there exists en open cover $(U_i)_{i \in I}$ of X and $n_i \in \mathbb{N}$, such that $(\mathscr{I}\,|_{U_i})^{n_i+1} = 0$. For $n \in \mathbb{N}$ we call ι a thickening of order n, if $\mathscr{I}^{n+1} = 0$. A thickening of order 1 is called a first order thickening.*

Definition 4.2 (Étalé ring maps): *(Görtz, Wedhorn, 2023, (18.4), p. 36) We call an R-algebra A formally étalé, iff for all rings C and all ideals $I \lhd C$ the following diagram admits a unique morphism $A \to C$.*

$$
\begin{array}{ccc}
C/I & \longleftarrow & A \\
\uparrow & \nwarrow & \uparrow \\
C & \longleftarrow & R
\end{array}
$$

Definition 4.3 (Formally étalé morphism of affine schemes): *Analogously to definition 4.2 we define a morphism of affine schemes $\mathrm{Spec}(A) \to \mathrm{Spec}(B)$ to be formally étalé, iff for all closed immersions $\mathrm{Spec}(R/I) \to \mathrm{Spec}(R)$ it*

admits a unique lift fitting into this commutative diagram:

$$
\begin{array}{ccc}
\mathrm{Spec}(R/I) & \longrightarrow & \mathrm{Spec}(A) \\
\downarrow & \nearrow & \downarrow \\
\mathrm{Spec}(R) & \longrightarrow & \mathrm{Spec}(B)
\end{array}
$$

This naturally leads to the definition of formally étalé morphisms of schemes:

Definition 4.4 (Formally étalé morphism of schemes): *(Görtz, Wedhorn, 2023, (Definition 18.3), p. 32) A morphism of schemes $X \to S$ is called formally étalé, iff for all first order thickenings $T_0 \to T$ with affine T, there exists a unique lift fitting into this diagram:*

$$
\begin{array}{ccc}
T_0 & \longrightarrow & X \\
\downarrow & \nearrow & \downarrow \\
T & \longrightarrow & S
\end{array}
$$

Proposition 4.5 : *Formally étalé morphisms are stable under composition and base change.*

Satz 1 (Locality of étalé morphism): *(Görtz, Wedhorn, 2023, Theorem 18.42, p. 44) Let $f : X \to S$ be a morphism of schemes locallly of finite presentation. Let $x \in X$ and $s := f(x)$. Then f is étalé at x, iff there exists an open affine $V = \mathrm{Spec}(R)$ of s and an open affine $U = \mathrm{Spec}(A) \subset f^{-1}(V)$ of x, such that A is isomorphic to the standard étalé R-algebra.*

Beweis. Inhalt... $\square$

5 Grothendieck Topology

In this chapter we want to define a Grothendieck topology on a category. Given a topological space X, the open sets define a category, where the objects are the open sets of X and morphisms are given by inclusion. In algebraic geometry one tries to analyze sheaves of the space X. The category associated to X encodes the coverings of open subest of X by opens.

The notion of a Grothendieck topology will generalize this for arbitrary categories and arbitrary "coverings"

Definition 5.1 (Sieve): *(Mac Lane, Moerdijk, 1992, p. 38) Let $X \in \mathscr{C}$ be an object of a small category. A sieve on X is a subfunctor of the representable presheaf $\mathrm{Hom}_{\mathscr{C}}(-, X)$. We will write $y(X)$ for the Yoneda embedding $\mathrm{Hom}_{\mathscr{C}}(-, X)$.*

Definition 5.2 (Grothendieck Topology): *(Mac Lane, Moerdijk, 1992, (Definition 1), p. 110) A Grothendieck topology J on a small categrory $\mathscr{C}$ is a function that assigns to each object $X \in C$ a collection of sieves $J(X)$ called covering sieves, such that the following axioms are satisfied:*

1. *For each object $X \in \mathscr{C}$ $\mathrm{Hom}_{\mathscr{C}}(-, X)$ is a sieve.*

2. *For each morphism $f : X \to Y$ in $\mathscr{C}$ and each sieve $S \in J(Y)$ the pullback $f^*(S) \in J(X)$ is a sieve on X.*

3. *For each covering sieve $S \in J(Y)$ and each sieve R on Y, such that $f^*(R) \in J(X)$ for all $f : X \to Y \in S$, then $R \in J(Y)$*

Bemerkung 1 : *For a sieve S on $Y \in \mathscr{C}$ and any $f : X \to Y$ in $\mathscr{C}$ we have*
$f^*S = \{g : Z \to X \mid f \circ g \in S\} \subset \mathrm{Hom}_{\mathscr{C}}(-, X)$

Definition 5.3 (Site): *(Mac Lane, Moerdijk, 1992, p. 110) For a small category $\mathscr{C}$ and a Grothendieck topology J we will call the pair $(\mathscr{C}, J)$ a site on $\mathscr{C}$.*

Definition 5.4 (Matching family): *(Mac Lane, Moerdijk, 1992, p. 121) Let $(\mathscr{C}, J)$ be a site, $P : \mathscr{C}^{\mathrm{op}} \to \mathsf{Set}$ a presheaf on $\mathscr{C}$ and $S \in J(C)$ a covering sieve. A matching familiy for S of elements of P is natural transformation $\eta : S \Rightarrow P$.*

This assigns to each $f : D \to C \in S(D)$ an element $x_f \in P(D)$, such that $P(g)(x_f) = x_{f \circ g}$ for all $g : E \to D \in \mathscr{C}$. Notice that $f \circ g \in S(E)$, since S is a sieve.

An amalgation of the matching family η is an element $x \in P(C)$, such that $P(f)(x) = x_f$ for all $f \in S$

Definition 5.5 (Sheaf): *(Mac Lane, Moerdijk, 1992, (p. 121) Let $(\mathscr{C}, J)$ be a site. A presheaf $P : \mathscr{C}^{\mathrm{op}} \to \mathsf{Set}$ is a sheaf, iff for every covering sieve $S \in J(C)$ the following diagramm admits a unique lift:*

$$
\begin{array}{ccc}
S & \longrightarrow & P \\
\downarrow & \nearrow & \\
y(C) & &
\end{array}
$$

Write $\mathsf{Sh}(\mathscr{C}, J) \subset \mathsf{PSh}(\mathscr{C})$ for the full subcategory of sheaves.

Bemerkung 2 : *(Mac Lane, Moerdijk, 1992, (p. 122) Let $(\mathscr{C}, J)$ be a site.*

Hilfssatz 1 (Sheafication): *Let $(\mathscr{C}, J)$ be a site, then the fully faithful inclusion $\iota : \mathsf{Sh}(\mathscr{C}, J) \hookrightarrow \mathsf{PSh}(\mathscr{C})$ admits a left adjoint $\tau \dashv \iota$.*

6 Methods

Please rename this chapter as you please.

6.1 New Section

Dies hier ist ein Blindtext zum Testen von Textausgaben. Wer diesen Text liest, ist selbst schuld. Der Text gibt lediglich den Grauwert der Schrift an. Ist das wirklich so? Ist es gleichgültig, ob ich schreibe: „Dies ist ein Blindtext" oder „Huardest gefburn"? Kjift – mitnichten! Ein Blindtext bietet mir wichtige Informationen. An ihm messe ich die Lesbarkeit einer Schrift, ihre Anmutung, wie harmonisch die Figuren zueinander stehen und prüfe, wie breit oder schmal sie läuft. Ein Blindtext sollte möglichst viele verschiedene Buchstaben enthalten und in der Originalsprache gesetzt sein. Er muss keinen Sinn ergeben, sollte aber lesbar sein. Fremdsprachige Texte wie „Lorem ipsum" dienen nicht dem eigentlichen Zweck, da sie eine falsche Anmutung vermitteln. Dies hier ist ein Blindtext zum Testen von Textausgaben. Wer diesen Text liest, ist selbst schuld. Der Text gibt lediglich den Grauwert der Schrift an. Ist das wirklich so? Ist es gleichgültig, ob ich schreibe: „Dies ist ein Blindtext" oder „Huardest gefburn"? Kjift – mitnichten! Ein Blindtext bietet mir wichtige Informationen. An ihm messe ich die Lesbarkeit einer Schrift, ihre Anmutung, wie harmonisch die Figuren zueinander stehen und prüfe, wie breit oder schmal sie läuft. Ein Blindtext sollte möglichst viele verschiedene Buchstaben enthalten und in der Originalsprache gesetzt sein. Er muss keinen Sinn ergeben, sollte aber lesbar sein. Fremdsprachige Texte wie „Lorem ipsum" dienen nicht dem eigentlichen Zweck, da sie eine falsche Anmutung vermitteln.

7 Results and Discussion

8 Conclusion and Outlook

Some introducing words ...

8.1 Conclusion

What are the most relevant aspects of your thesis? Which important questions from your introduction could be answered?

8.2 Outlook and Future Directions

Given the results obtained in this thesis, which aspects need be improved? Which additional effects or phenomena should be studied?

Literaturverzeichnis

Görtz, U., T. Wedhorn (2023): *Algebraic Geometry II: Cohomology of Schemes. With Examples and Exercises.* 1. Aufl. Wiesbaden: Springer Spektrum. ISBN: 978-3-658-43031-3. DOI: 10.1007/978-3-658-43031-3. URL: https://link.spri nger.com/book/10.1007/978-3-658-43031-3 (letzter Zugriff 22.01.2026) (zit. auf den S. 35, 36).

Mac Lane, S., I. Moerdijk (1992): *Sheaves in Geometry and Logic. A First Introduction to Topos Theory.* 1. Aufl. Universitext. New York, NY: Springer. ISBN: 978-0-387-97710-2. DOI: 10.1007/978-1-4612-0927-0. URL: https://lin k.springer.com/book/10.1007/978-1-4612-0927-0 (letzter Zugriff 22.01.2026) (zit. auf den S. 37, 38).

Anhang A

Code Examples

A.1 AMPL

```
1  reset;  # all blue words are keywords in this language
2          # they are defined in the file 01_Document_administration/
               f_CodeLanguageSpecifications.tex
3
4  model simulation.mod;
5  data simulation.dat;
6  include initial.dat;
7  option ipoptoptions "halt_on_ampl_error_yes";
8
9  let e0_param := 4;
10
11 solve;
```

Code A.1: Code example for AMPL.

A.2 Matlab

```
1  clc
2  clear
3  close all
4
5  e0_param = 4;
6
7  j=0;
```

```matlab
8  for i=1:e0_params % this loop is incredibly smart
9      if 1==2
10         j=j+1;
11     else
12         j=j-1;
13     end
14 end
```

Code A.2: Code example for Matlab.

Anhang B

Examples of the longtable Environment

Especially in the appendix, it is common that long tables appear, which contain experimental or simulated data. For this purpose, the `longtable` environment can be used. The `\autoref` command to reference tables works for them as well (Tab. B.1).

Tab. B.1: This is a longtable, because it is a long table.

Ragged right	Ragged left	Justified	Parbox
Result A	Result B	Result C	Result D
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.

Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.

Tab. B.2: The caption of a long table on the first page.

Ragged right	Ragged left	Justified	Parbox
Result A	Result B	Result C	Result D
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.

Tab. B.2 (continued).

Ragged right	Ragged left	Justified	Parbox
Result A	Result B	Result C	Result D
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.
Text.	Text.	Text.	Longer text to create line breaks.

Anhang C

Automatic Indenting in arara

In the following, the instructions on using `arara` for automatic indenting are shown for a Windows operating system. It is assumed that the instructions are similar on a Unix system, because `arara` is platform independent. However, this has not been verified, yet. In addition, we expect every person using this template to have installed TeXLive $\geq$ 2018 and the following instructions are only valid for these cases. If you *have* to use an older TeXLive version, please check earlier commits of this template for the necessary instructions and files.

4.0 (TeXLive $\geq$ 2018):

1. Add a user command for `arara` to Texmaker[1].

2. Add the command in Code C.1 to the beginning of the `main.tex` file (right before anything else). Note that the % before arara is *intentional* and necessary. This command executes the automatic file indenting for all files (and files in subfolders) that are stated within the square brackets as soon as `arara` is started. An example is given in Abb. C.1.

3. Execute `arara` (if you added it as the first user command, the shortcut Alt+Shift+F1 may be used).

4. Update your files by clicking on File $\rightarrow$ Reload all documents from file.

5. Your source code should now be nicely indented.

---

[1] https://tex.stackexchange.com/questions/107989/integration-of-arara-in-texmaker, January 2019

6. In case errors appear, `arara` always creates a backup with the file extension `.latexindentbackup`.

Note that `arara` 4.0 does not work with subdirectories by default.

```
% arara: indentsubdir: { overwrite : yes, files : [ folder/file1.tex,
    folder/file2.tex ] , settings: local, where: 00_Arara_and_Latexindent
    /localSettings.yaml }
```

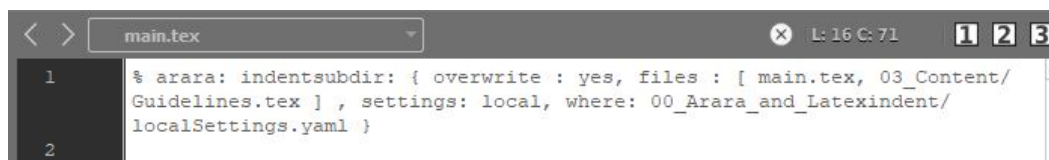**Code C.1:** Setting up `arara` for `latexindent` in Texmaker.

Abb. C.1: Directives for arara execution for automatic indenting. These commands must be added at the beginning of `main.tex`.

5.0 (TEXLive ≥ 2020):

As maintaining the code and keeping up-to-date with changes in `arara` is too cumbersome, these sections will not be updated with every new version of `arara`. Instead, the instructions above shall serve as starting point in newer versions of TEXLive.

Anhang D

Package Dependencies

Tab. D.1: List of all packages in this template. Packages without version number are part of the LaTeX distribution and are updated with every update of TeXLive itself.

Package name	Version	Reference
Document class		
KOMA script	3.48	https://ctan.org/pkg/koma-script
Document and encoding		
babel	25.13	https://ctan.org/pkg/babel?lang=de
calc	4.3b	https://ctan.org/pkg/calc?lang=de
datetime2	1.5.7	https://ctan.org/pkg/datetime2
fontenc	–	https://ctan.org/pkg/fontenc
ifthen	1.4.0	https://ctan.org/pkg/ifthen
microtype	3.2b	https://ctan.org/pkg/microtype
morewrites	–	https://ctan.org/pkg/morewrites?lang=de
pdfpages	0.6g	https://ctan.org/pkg/pdfpages?lang=de
scrlayer-scrpage	3.48	https://ctan.org/pkg/scrlayer-scrpage
textcomp	–	https://ctan.org/pkg/textcomp
todonotes	1.1.7	https://ctan.org/pkg/todonotes?lang=de
xparse	–	https://ctan.org/pkg/xparse
Tables		
array	–	https://ctan.org/pkg/array?lang=de
booktabs	1.61803398	https://ctan.org/pkg/booktabs

Tab. D.1 (continued).

Package name	Version	Reference
collcell	0.6	https://ctan.org/pkg/collcell?lang=en
longtable	–	https://ctan.org/pkg/longtable
multirow	2.9	https://ctan.org/pkg/multirow
supertabular	4.2c	https://ctan.org/pkg/supertabular?lang=en
tabularx	–	https://ctan.org/pkg/tabularx
threeparttable	–	https://ctan.org/pkg/threeparttable?lang=de
threeparttablex	0.3	https://ctan.org/pkg/threeparttablex
Graphics		
graphicx	–	https://ctan.org/pkg/graphicx
overpic	2.1	https://ctan.org/pkg/overpic
wrapfig	3.6	https://ctan.org/pkg/wrapfig2
Fonts, math, and symbols		
amsmath	–	https://ctan.org/pkg/amsmath
amssymb	–	
amsthm	–	https://ctan.org/pkg/amsthm
cancel	2.2	https://ctan.org/pkg/cancel
chemfig	1.66	https://ctan.org/pkg/chemfig
chemmacros	6.2a	https://ctan.org/pkg/chemmacros?lang=de
courier	–	https://ctan.org/pkg/courier
helvet	–	https://ctan.org/pkg/helvet?lang=de
icomma	–	https://ctan.org/pkg/icomma
mathtools	1.31	https://ctan.org/pkg/mathtools
nicefrac	–	https://ctan.org/pkg/nicefrac
optidef	3.1	https://ctan.org/pkg/optidef
upgreek	2.0	https://ctan.org/pkg/upgreek
Units		
siunitx	3.4.14	https://ctan.org/pkg/siunitx
Text		
algorithm2e	5.2	https://ctan.org/pkg/algorithm2e
blindtext	2.0	https://ctan.org/pkg/blindtext
caption	–	https://ctan.org/pkg/caption

Tab. D.1 (continued).

Package name	Version	Reference
enumitem	3.11	https://ctan.org/pkg/enumitem
footnote	1.13	https://ctan.org/pkg/footnote
mdframed	1.9b	https://ctan.org/pkg/mdframed
nowidow	1.0	https://ctan.org/pkg/nowidow
placeins	2.2	https://ctan.org/pkg/placeins
setspace	6.7b	https://ctan.org/pkg/setspace
subcaption	1.6	https://ctan.org/pkg/subcaption
xcolor	3.02	https://ctan.org/pkg/xcolor
References		
biblatex	3.21	https://ctan.org/pkg/biblatex
csquotes	5.2o	https://ctan.org/pkg/csquotes
Lists of Symbols and Abbreviations		
acro	3.8	https://ctan.org/pkg/acro?lang=de
nomencl	5.6	https://ctan.org/pkg/nomencl?lang=de
Index		
imakeidx	1.3e	https://ctan.org/pkg/imakeidx?lang=de
Code		
listings	1.10c	https://ctan.org/pkg/listings
URLs		
xurl	0.10	https://ctan.org/pkg/xurl?lang=de
Hyperref and pdfx		
hyperref	7.01o	https://ctan.org/pkg/hyperref
pdfx	1.6.5f	https://ctan.org/pkg/pdfx

Anhang E

Auto-completion

Texmaker (and propably many other editors) offer the possibility to define additional commands for automatic completion. This means they are suggested when you type a command. They can be edited under User $\rightarrow$ Customize Completion. The commands, which are assumed to be used on a regular basis in a thesis, are stated in Tab. E.1. You can simply copy each line and add it to your Texmaker. This takes approximately five minutes and saves you a lot of time when you actually write something, especially units.

Tab. E.1: List of recommended auto-complete commands in Texmaker.

Command	Explanation
`\ac{@}`	Acronym in text
`\ampere`	A unit
`\Autoref{#label#}`	Autoref with capitalized first letter
`\bar`	bar unit
`\begin{algorithm}`	new algorithm
`\begin{definition}`	new definition
`\begin{lemmaenv}`	new lemma
`\begin{longtable}{@}`	new long table
`\begin{mdframed}`	new frame
`\begin{overpic}[@]{@}`	new frame
`\begin{remarkenv}`	new remark
`\begin{tablenotes}`	table notes in three part table

Tab. E.1 (continued).

Command	Explanation
\begin{theoremenv}	new theorem
\begin{threeparttable}	new three part table
\bottomrule	bottom rule in tabulars
\celsius	°C unit
\ch{@}	new chemical formula
\cubic	for cubed unit
\enquote{@}	new quote in current language
\gram	g unit
\joule	J unit
\kelvin	K unit
\kilo	for kilo in units
\mega	for mega in units
\metre	m unit
\midrule	mid rule in tabulars
\milli	for milli in units
\missingfigure[@]{@}	new missing figure with options
\missingfigure{@}	new missing figure without options
\mole	mol unit
\myfigure[@][@]{@}[@]{@}[@]	new figure
\nomenclature{@}{@}{@}{@}	new symbol
\num{@}	new number
\parencite[@]{#bib#}	new paren cite with options
\parencite{#bib#}	new paren cite without options
\pascal	Pa unit
\pder[@][@]{@}	partial derivative
\per	division command in units
\qty{@}{@}	new number with unit
\qtyrange{@}{@}{@}	new range for units
\roundbrack{@}	round brackets around argument
\squared	for squared unit
\textcite[@]{#bib#}	new text cite with option

Tab. E.1 (continued).

Command	Explanation
`\textcite{#bib#}`	new text cite without option
`\todo[@]{@}`	new todo with option
`\todo{@}`	new todo without option
`\toprule`	top rule in tabulars
`\tothe{@}`	for power in units
`\unit{@}`	new unit
`\verb`	for verbat output
`\volt`	V unit
`\watt`	W unit

Anhang F

Large Figures

This appendix contains two examples of how to include a large figure, e.g., a P&I diagram, into the thesis when it is desirable to have it in DIN A3.

F.1 Include as Figure

In this case, the page format is changed to DIN A3 and the figure is included as a float (see Abb. F.1).

F.2 Include as Page

In another approach, the page format is changed to DIN A3 and the figure is included as PDF to cover the whole page. The disadvantage of this approach is having no caption to reference the figure in the text. This may be resolved with a reference to the page, here: page 67.
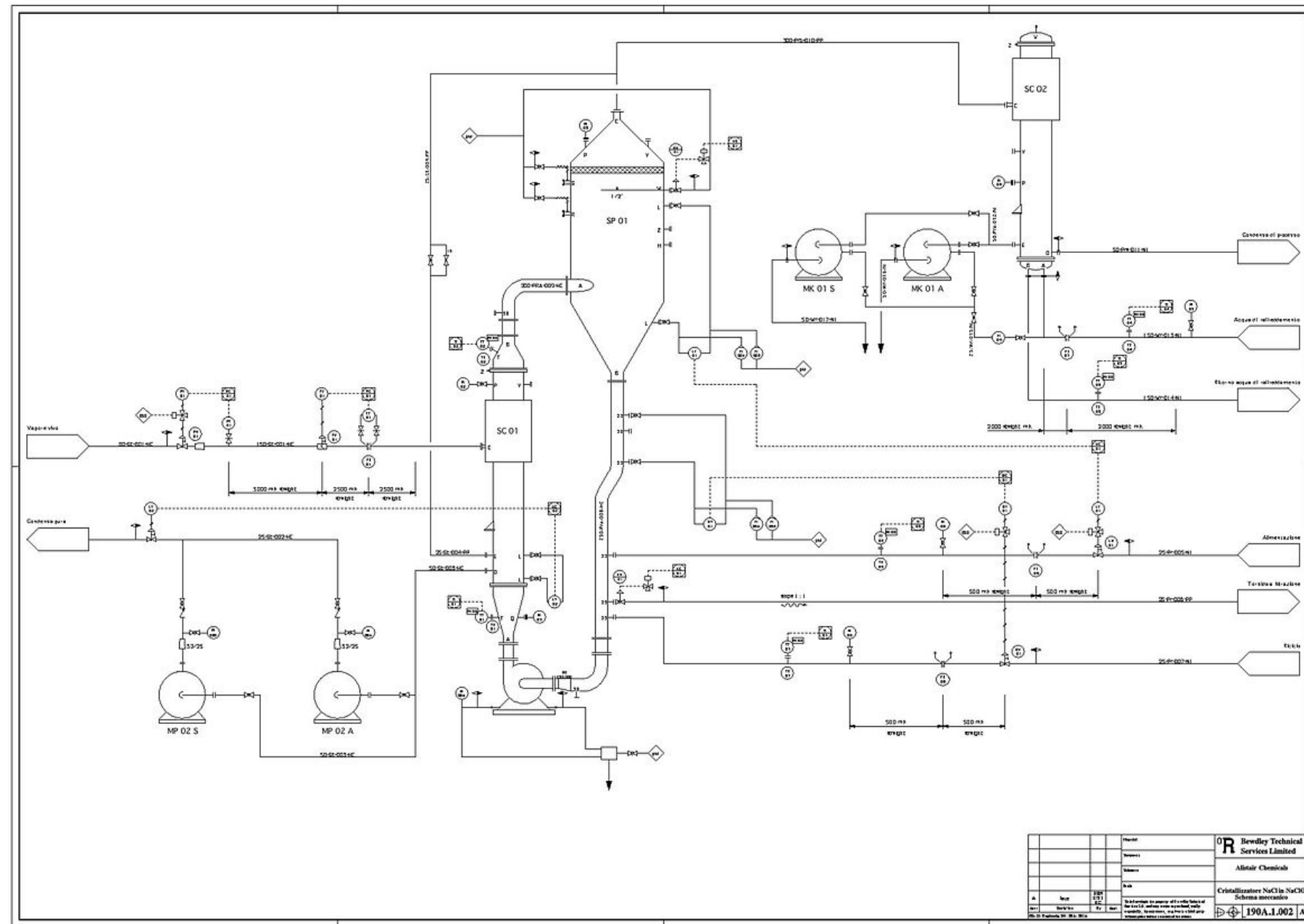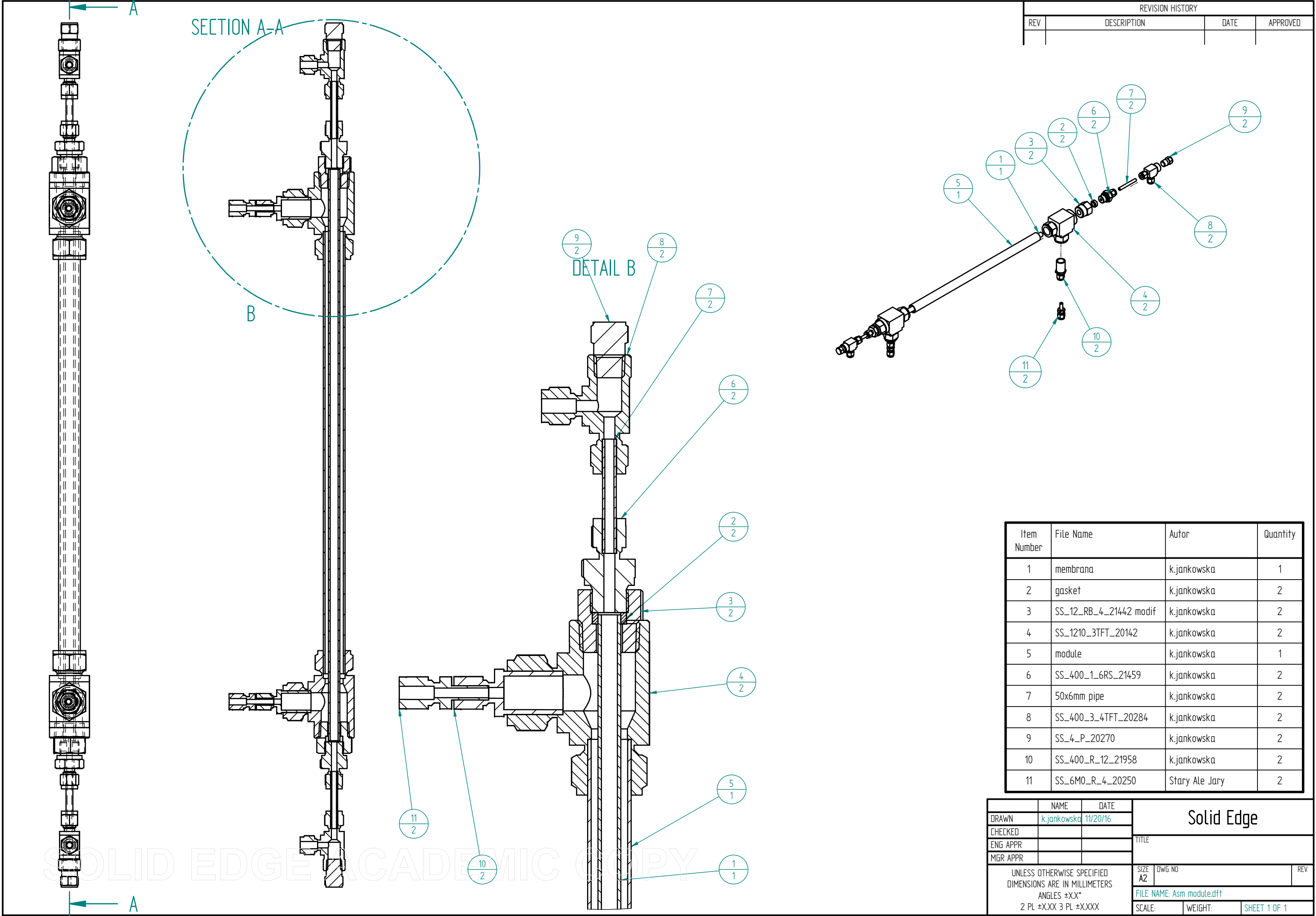
Abb. F.1: Example of a large figure for DIN A3; taken from Wikipedia.

This page intentionally left blank

SECTION A-A

DETAIL B

B

Item Number	File Name	Autor	Quantity
1	membrana	k.jankowska	1
2	gasket	k.jankowska	2
3	SS_12_RB_4_21442 modif	k.jankowska	2
4	SS_1210_3TFT_20142	k.jankowska	2
5	module	k.jankowska	1
6	SS_400_1_6RS_21459	k.jankowska	2
7	50x6mm pipe	k.jankowska	2
8	SS_400_3_4TFT_20284	k.jankowska	2
9	SS_4_P_20270	k.jankowska	2
10	SS_400_R_12_21958	k.jankowska	2
11	SS_6M0_R_4_20250	Stary Ale Jary	2

	NAME	DATE	Solid Edge
DRAWN	k.jankowska	11/20/16	
CHECKED			TITLE
ENG APPR			
MGR APPR			

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS
ANGLES ±X.X°
2 PL ±X.XX 3 PL ±X.XXX

SIZE A2 | DWG NO | REV

FILE NAME: Asm module.dft

SCALE: | WEIGHT: | SHEET 1 OF 1

This page intentionally left blank

Indexverzeichnis

S

T