

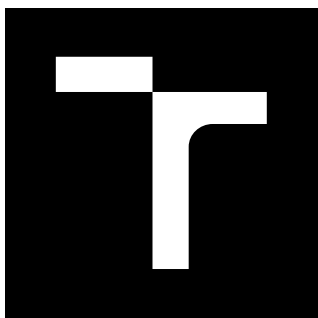
BRNO UNIVERSITY OF TECHNOLOGY

Faculty of Electrical Engineering  
and Communication

SEMESTRAL THESIS

Use your personalized  
cover generated by the  
BUT information system





# BRNO UNIVERSITY OF TECHNOLOGY

VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

## FACULTY OF ELECTRICAL ENGINEERING AND COMMUNICATION

FAKULTA ELEKTROTECHNIKY  
A KOMUNIKAČNÍCH TECHNOLOGIÍ

## DEPARTMENT OF MICROELECTRONICS

ÚSTAV MIKROELEKTRONIKY

## CHANNEL MERGING TECHNIQUES FOR IMPROVING DYNAMIC RANGE OF $\pm 10V$ SIGNAL CHAIN CHANNEL

TECHNIKY SLUČOVÁNÍ KANÁLŮ ZA ÚČELEM ZVÝŠENÍ DYNAMICKÉHO ROZSAHU KANÁLU S  
ROZSAHEM  $\pm 10V$

SEMESTRAL THESIS  
SEMESTRÁLNÍ PRÁCE

AUTHOR  
AUTOR PRÁCE

SUPERVISOR  
VEDOUCÍ PRÁCE

Bc. Sa

Ing. Vil

Use your personalized  
titlepage generated by  
the BUT information  
system

BRNO 2020



# Master's Thesis

study programme  
specialization  
Department of Telecommunications

**Student:**

**ID:** 0

**Year of study:** 0

**Academic year:** 2019/20

**TITLE OF THESIS:**

**INSTRUCTION:**

**REFERENCE:**

[1] HUANG, Scott C.-H, David MACCALLUM a Dingzhu DU. Network security. New York: Springer, 2007. ISBN isbn978-0-387-73821-5.

[2] KIM, Kwangjo. Network intrusion detection using deep learning: a feature learning approach. New York, NY: Springer Berlin Heidelberg, 2018. ISBN 9789811314438.

**Assignment deadline:** 23. 9. 2019

**Submission deadline:** 21. 12. 2019

**Head of thesis:** Ing. Josef Brychta

Use your personalized  
assignment generated  
by the BUT information  
system

board

**WARNING:**

The author of this Master's Thesis claims that by creating this thesis he/she did not infringe the rights of third persons and the personal and/or property rights of third persons were not subjected to derogatory treatment. The author is fully aware of the legal consequences of an infringement of provisions as per Section 11 and following of Act No 121/2000 Coll. on copyright and rights related to copyright and on amendments to some other laws (the Copyright Act) in the wording of subsequent directives including the possible criminal consequences as resulting from provisions of Part 2, Chapter VI, Article 4 of Criminal Code 40/2009 Coll.



## DECLARATION

I declare that I have written the semestral project titled "Title of Student's Thesis" independently, under the guidance of the advisor and using exclusively the technical references and other sources of information cited in the project and listed in the comprehensive bibliography at the end of the project.

As the author I furthermore declare that, with respect to the creation of this semestral project, I have not infringed any copyright or violated anyone's personal and/or ownership rights. In this context, I am fully aware of the consequences of breaking Regulation § 11 of the Copyright Act No. 121/2000 Coll. of the Czech Republic, as amended, and of any breach of rights related to intellectual property or introduced within amendments to relevant Acts such as the Intellectual Property Act or the Criminal Code, Act No. 40/2009 Coll., Section 2, Head VI, Part 4.

Brno .....

.....

author's signature





# Contents

<b>Introduction</b>	<b>15</b>
<b>1 Theory</b>	<b>17</b>
<b>2 Thesis Results</b>	<b>19</b>
2.1 Selection of Programming Language . . . . .	19
2.2 Implementation . . . . .	19
2.2.1 Tests and Evaluation . . . . .	19
<b>Conclusion</b>	<b>23</b>
<b>Bibliography</b>	<b>25</b>
<b>List of symbols, quantities and abbreviations</b>	<b>27</b>
<b>List of appendices</b>	<b>29</b>
<b>A Selected Commands of thesis Package</b>	<b>31</b>
A.1 Quantities and Units . . . . .	31
A.2 Symbols . . . . .	31
<b>B Next Appendix</b>	<b>33</b>
<b>C Examples of Listing Computer Codes</b>	<b>35</b>
C.1 Package listings . . . . .	35
<b>D Content of the Attached CD/DVD</b>	<b>39</b>



# List of Figures

B.1 Wilson mirror . . . . .	33
-----------------------------	----



# List of Tables

A.1 An overview of commands . . . . .	31
---------------------------------------	----



# Listings

C.1	Example of code listing . . . . .	35
C.2	Example of the Schur–Cohn test of stability in Matlab . . . . .	36
C.3	Example of implementation of first canonical form in C . . . . .	37





# Introduction

Here comes the introduction of the thesis, for example . . .

This thesis is devoted to DSP (Digital Signal Processing), especially it analyses the effect happening when the Nyquist condition for *sampling frequency* ( $f_s$ ) is not satisfied.<sup>1</sup>

---

<sup>1</sup>This sentence is only to demonstrate how abbreviations can be used and typeset.



# 1 Theory

Theoretical background of the thesis comes now, suitably split into chapters and sections.

(The structure suggested in this template is the coarsest one. Please discuss your particular structure with your adviser.)



## 2 Thesis Results

Practical part and results of the student, suitably split into chapters and sections.

### 2.1 Selection of Programming Language

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nulla pulvinar eleifend sem. Integer in sapien. Etiam sapien elit, consequat eget, tristique non, venenatis quis, ante. In laoreet, magna id viverra tincidunt, sem odio bibendum justo, vel imperdiet sapien wisi sed libero. Phasellus enim erat, vestibulum vel, aliquam a, posuere eu, velit. Aliquam erat volutpat. Nullam faucibus mi quis velit [1].

### 2.2 Implementation

Fusce tellus odio, dapibus id fermentum quis, suscipit id erat. Fusce tellus. Morbi scelerisque luctus velit. In laoreet, magna id viverra tincidunt, sem odio bibendum justo, vel imperdiet sapien wisi sed libero. Quisque porta. Fusce suscipit libero eget elit. Nulla non lectus sed nisl molestie malesuada. Phasellus faucibus molestie nisl. Integer vulputate sem a nibh rutrum consequat. Proin mattis lacinia justo. Phasellus et lorem id felis nonummy placerat. Etiam ligula pede, sagittis quis, interdum ultricies, scelerisque eu. Cras elementum. Aenean placerat. Donec ipsum massa, ullamcorper in, auctor et, scelerisque sed, est. Aliquam ante. Integer imperdiet lectus quis justo. Vivamus ac leo pretium faucibus. Nullam faucibus mi quis velit.

#### 2.2.1 Tests and Evaluation

Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Aliquam erat volutpat. Lorem ipsum dolor sit amet, consectetur adipiscing elit [1, 6]. Nunc auctor. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Maecenas lorem. Maecenas libero. In laoreet, magna id viverra tincidunt, sem odio bibendum justo, vel imperdiet sapien wisi sed libero. Nullam rhoncus aliquam metus.

#### **Integer rutrum orci vestibulum**

Integer rutrum, orci vestibulum ullamcorper ultricies, lacus quam ultricies odio, vitae placerat pede sem sit amet enim. Ut enim ad minim veniam, quis nostrud

exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Fusce tellus odio, dapibus id fermentum quis, suscipit id erat. Nullam eget nisl. Nunc auctor. Etiam dui sem, fermentum vitae, sagittis id, malesuada in, quam. Fusce dui leo, imperdiet in, aliquam sit amet, feugiat eu, orci. Curabitur vitae diam non enim vestibulum interdum. Aliquam erat volutpat. Pellentesque sapien. Phasellus enim erat, vestibulum vel, aliquam a, posuere eu, velit.

### **Eger rutrum orci vestibulum**

Fusce dui leo, imperdiet in, aliquam sit amet, feugiat eu, orci. Maecenas aliquet accumsan leo. Aliquam ornare wisi eu metus. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam erat volutpat. Donec iaculis gravida nulla. Sed elit dui, pellentesque a, faucibus vel, interdum nec, diam. Temporibus autem quibusdam et aut officiis debitis aut rerum necessitatibus saepe eveniet ut et voluptates repudiandae sint et molestiae non recusandae. Nulla non arcu lacinia neque faucibus fringilla. Phasellus enim erat, vestibulum vel, aliquam a, posuere eu, velit. Praesent vitae arcu tempor neque lacinia pretium [7, 8, 9].

Aliquam erat volutpat. Quisque porta. Integer imperdiet lectus quis justo. Nullam justo enim, consectetur nec, ullamcorper ac, vestibulum in, elit. Nullam faucibus mi quis velit. Fusce tellus. Fusce consectetur risus a nunc. Cras pede libero, dapibus nec, pretium sit amet, tempor quis. Morbi imperdiet, mauris ac auctor dictum, nisl ligula egestas nulla, et sollicitudin sem purus in lacus [2, 3, 4]. Mauris elementum mauris vitae tortor. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem. Quisque porta. Integer vulputate sem a nibh rutrum consequat. Nulla pulvinar eleifend sem. Praesent id justo in neque elementum ultrices [5].

Fusce suscipit libero eget elit. Integer vulputate sem a nibh rutrum consequat. Aliquam erat volutpat. Etiam neque. Nulla turpis magna, cursus sit amet, suscipit a, interdum id, felis. Nullam rhoncus aliquam metus. Etiam dui sem, fermentum vitae, sagittis id, malesuada in, quam. Nunc auctor. Nunc dapibus tortor vel mi dapibus sollicitudin. Praesent in mauris eu tortor porttitor accumsan. Nulla non arcu lacinia neque faucibus fringilla. Nullam lectus justo, vulputate eget mollis sed, tempor sed magna. Maecenas lorem. Aenean placerat. Donec vitae arcu. Maecenas lorem. Donec iaculis gravida nulla. Nulla non lectus sed nisl molestie malesuada.

Duis pulvinar. Nulla est. Duis condimentum augue id magna semper rutrum. Integer pellentesque quam vel velit. Aliquam ante. Nulla quis diam. Proin mattis lacinia justo. Aenean fermentum risus id tortor. Nunc auctor. Nullam justo enim, consectetur nec, ullamcorper ac, vestibulum in, elit. In dapibus augue non sapien.

Etiam bibendum elit eget erat. In sem justo, commodo ut, suscipit at, pharetra vitae, orci. Maecenas libero.

Nulla non lectus sed nisl molestie malesuada. Donec vitae arcu. Aenean fermentum risus id tortor. Praesent in mauris eu tortor porttitor accumsan. Nulla pulvinar eleifend sem. Duis viverra diam non justo. Integer imperdiet lectus quis justo. Pellentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas. In rutrum. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum. Nulla non lectus sed nisl molestie malesuada. Aliquam erat volutpat. Mauris tincidunt sem sed arcu. Duis bibendum, lectus ut viverra rhoncus, dolor nunc faucibus libero, eget facilisis enim ipsum id lacus. Fusce tellus odio, dapibus id fermentum quis, suscipit id erat. In enim a arcu imperdiet malesuada. Nulla non lectus sed nisl molestie malesuada. Proin mattis lacinia justo.

Aliquam in lorem sit amet leo accumsan lacinia. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Duis sapien nunc, commodo et, interdum suscipit, sollicitudin et, dolor. Suspendisse sagittis ultrices augue. Nullam lectus justo, vulputate eget mollis sed, tempor sed magna. In convallis. Praesent id justo in neque elementum ultrices. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem.

Pellentesque pretium lectus id turpis. Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos qui ratione voluptatem sequi nesciunt. Curabitur ligula sapien, pulvinar a vestibulum quis, facilisis vel sapien. Praesent dapibus. Sed elit dui, pellentesque a, faucibus vel, interdum nec, diam. Duis viverra diam non justo. Duis ante orci, molestie vitae vehicula venenatis, tincidunt ac pede. Phasellus rhoncus. Maecenas fermentum, sem in pharetra pellentesque, velit turpis volutpat ante, in pharetra metus odio a lectus. Proin pede metus, vulputate nec, fermentum fringilla, vehicula vitae, justo. Fusce aliquam vestibulum ipsum. Nullam at arcu a est sollicitudin euismod.





# Conclusion

Thesis conclusion.



## Bibliography

- [1] VUT v Brně: *Úprava, odevzdávání a zveřejňování vysokoškolských kvalifikačních prací na VUT v Brně* [online]. Směrnice rektora č. 2/2009. Brno: 2009, poslední aktualizace 24. 3. 2009 [cit. 23. 10. 2015]. Dostupné z URL: <<https://www.vutbr.cz/uredni-deska/vnitрни-predpisy-a-dokumenty/smernice-rektora-f34920/>>.
- [2] *ČSN ISO 690 (01 0197) Informace a dokumentace – Pravidla pro bibliografické odkazy a citace informačních zdrojů*. 40 stran. Praha: Český normalizační institut, 2011.
- [3] *ČSN ISO 7144 (010161) Dokumentace – Formální úprava disertací a podobných dokumentů*. 24 stran. Praha: Český normalizační institut, 1997.
- [4] *ČSN ISO 31-11 Veličiny a jednotky – část 11: Matematické znaky a značky používané ve fyzikálních vědách a v technice*. Praha: Český normalizační institut, 1999.
- [5] BIERNÁTOVÁ, O., SKŮPA, J.: *Bibliografické odkazy a citace dokumentů dle ČSN ISO 690 (01 0197) platné od 1. dubna 2011* [online]. 2011, poslední aktualizace 2. 9. 2011 [cit. 19. 10. 2011]. Dostupné z URL: <<http://www.citace.com/CSN-ISO-690.pdf>>
- [6] *Pravidla českého pravopisu*. Zpracoval kolektiv autorů. 1. vydání. Olomouc: FIN PUBLISHING, 1998. 575 s. ISBN 80-86002-40-3.
- [7] WALTER, G. G.; SHEN, X. *Wavelets and Other Orthogonal Systems*. 2. vyd. Boca Raton: Chapman & Hall/CRC, 2000. 392 s. ISBN 1-58488-227-1
- [8] SVAČINA, J. Dispersion Characteristics of Multilayered Slotlines – a Simple Approach. *IEEE Transactions on Microwave Theory and Techniques*, 1999, vol. 47, no. 9, s. 1826–1829. ISSN 0018-9480.
- [9] RAJMIC, P.; SYSEL, P. Wavelet Spectrum Thresholding Rules. In *Proceedings of the International Conference Research in Telecommunication Technology*, Žilina: Žilina University, 2002. s. 60–63. ISBN 80-7100-991-1.



# List of symbols, quantities and abbreviations

**Width of the left column of this list** is governed by the width of the parameter of `acronym` (see row 1 of the listing at page 35)

**HowMuchSpace** only to demonstrate how the space of the left column is reserved

**DSP** Digital Signal Processing

$f_s$  sampling frequency



# List of appendices

<b>A</b>	<b>Selected Commands of thesis Package</b>	<b>31</b>
A.1	Quantities and Units . . . . .	31
A.2	Symbols . . . . .	31
<b>B</b>	<b>Next Appendix</b>	<b>33</b>
<b>C</b>	<b>Examples of Listing Computer Codes</b>	<b>35</b>
C.1	Package listings . . . . .	35
<b>D</b>	<b>Content of the Attached CD/DVD</b>	<b>39</b>





# A Selected Commands of thesis Package

## A.1 Quantities and Units

Tab. A.1: An overview of commands (use within the mathematical environments).

Command	Example	L <sup>A</sup> T <sub>E</sub> X code of example	Meaning
<code>\textind{...}</code>	$\beta_{\max}$	<code>\$\$\beta_{\textind{max}}\$</code>	text-style index
<code>\const{...}</code>	$U_{\text{in}}$	<code>\$\$\const{U}_{\textind{in}}\$</code>	constant
<code>\var{...}</code>	$u_{\text{in}}$	<code>\$\$\var{u}_{\textind{in}}\$</code>	variable
<code>\complex{...}</code>	$\mathbf{u}_{\text{in}}$	<code>\$\$\complex{u}_{\textind{in}}\$</code>	complex variable
<code>\vect{...}</code>	$\mathbf{y}$	<code>\$\$\vect{y}\$</code>	vector
<code>\mat{...}</code>	$\mathbf{Z}$	<code>\$\$\mat{Z}\$</code>	matrix
<code>\unit{...}</code>	kV	<code>\$\$\unit{kV}\$</code> or <code>\unit{kV}</code>	unit

## A.2 Symbols

- `\E`, `\eu1` – typesets the Euler number: e,
- `\J`, `\jmag`, `\I`, `\imag` – imaginary unit: j, i,
- `\dif` – the differential: d,
- `\sinc` – the function sinc,
- `\mikro` – typesets the *micro* symbol in roman type<sup>1</sup>:  $\mu$ ,
- `\uppi` – typesets  $\pi$  (greek pi in roman type, in difference to `\pi`, which typesets  $\pi$ ).

All symbols are considered to be used within a math mode, except `\mikro` that is possible in the text mode as well.

---

<sup>1</sup>the symbol comes from package `textcomp`



## B Next Appendix

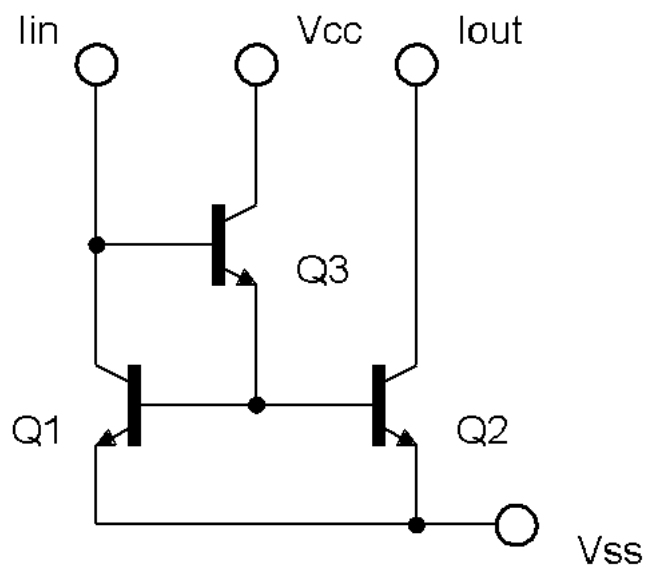


Fig. B.1: Improved Wilson current mirror.

For inclusion of the vector-based graphics directly via  $\LaTeX$ , it is possible to use the `TikZ` package. Examples of use can be found at the `TeXample` site. `TikZ` graphics creation is supported in `QTikz` and `TikzEdt` software.



# C Examples of Listing Computer Codes

## C.1 Package listings

Listing computer codes can be handled efficiently via the `listings` package. This package introduces a new environment `lstlisting` for typesetting computer codes, as for example:

```
\section{Package listings}
Listing computer codes can be handled efficiently
via the \texttt{listings} package.
This package introduces a new environment
\texttt{lstlisting} for typesetting computer codes.
```

The package supports a number of programming languages. The code to be typeset can be input directly from files on disk. The package allows row numbering and extracting only selected parts of the code. The following paragraph is an example of the use of `listings`:

Abbreviations are typeset with the `acronym` environment:

```
6 \begin{acronym}[HowMuchSpace]
```

The width of the input parameter, `HowMuchSpace`, determines the width of the first column. An example of the definition of abbreviation  $f_s$  is in Listing C.1.

Listing C.1: Example of code listing.

```
21 \acro{symfs}           % label of the abbrev.
22   [\ensuremath{f_\text{ind}{s}}] % symbol
23   {sampling frequency}      % full text
```

The list is finished with the end of the environment:

```
26 \end{acronym}
```

Listing C.2 contains an example of code for Matlab, whereas in Listing C.3 you find an example in the C language.

Listing C.2: Example of the Schur–Cohn test of stability in Matlab.

```

1 %% Příklad testování stability filtru
2
3 % koefficienty polynomu ve jmenovateli
4 a = [ 5, 11.2, 5.44, -0.384, -2.3552, -1.2288];
5 disp( 'Polynom:'); disp(poly2str( a, 'z'))
6
7 disp('Kontrola pomoci korenu polynomu:');
8 zx = roots( a);
9 if( all( abs( zx) < 1))
10     disp('System je stabilni')
11 else
12     disp('System je nestabilni nebo na mezistability');
13 end
14
15 disp(' '); disp('Kontrola pomoci Schur-Cohn:');
16 ma = zeros( length(a)-1,length(a));
17 ma(1,:) = a/a(1);
18 for( k = 1:length(a)-2)
19     aa = ma(k,1:end-k+1);
20     bb = fliplr( aa);
21     ma(k+1,1:end-k+1) = (aa-aa(end)*bb)/(1-aa(end)^2);
22 end
23
24 if( all( abs( diag( ma.'))))
25     disp('System je stabilni')
26 else
27     disp('System je nestabilni nebo na mezistability');
28 end

```

Listing C.3: Example of implementation of first canonical form in C.

```

// first canonical form
short fxdf2t( short coef[][5], short sample)
{
    static int v1[SECTIONS] = {0,0},v2[SECTIONS] = {0,0};
    int x, y, accu;
    short k;

    x = sample;
    for( k = 0; k < SECTIONS; k++){
        accu = v1[k] >> 1;
        y = _sadd( accu, _smpy( coef[k][0], x));
        y = _sshl(y, 1) >> 16;

        accu = v2[k] >> 1;
        accu = _sadd( accu, _smpy( coef[k][1], x));
        accu = _sadd( accu, _smpy( coef[k][2], y));
        v1[k] = _sshl( accu, 1);

        accu = _smpy( coef[k][3], x);
        accu = _sadd( accu, _smpy( coef[k][4], y));
        v2[k] = _sshl( accu, 1);

        x = y;
    }
    return( y);
}

```





## D Content of the Attached CD/DVD

Do not forget to describe the content of the attached medium! It is suggested to comment on every folder, to specify which of the files contains main settings, to specify which is the main or executable file etc. It is also valuable to specify in which version of the software the code has been tested (e.g. Matlab 2018b).

If your attachment contains a lot of files or folders,  $\text{\LaTeX}$  package `dirtree` can become handy, as in the following example.

```
/..... root of the attached CD
├── logo..... logotypes
│   ├── BUT_abbreviation_color_PANTONE_EN.pdf
│   ├── BUT_color_PANTONE_EN.pdf
│   ├── FEEC_abbreviation_color_PANTONE_EN.pdf
│   └── UTKO_color_PANTONE_EN.pdf
├── pdf.....PDFs (generate them in the information system)
│   ├── assignment-example.pdf
│   ├── cover-example.pdf
│   └── titlepage-example.pdf
├── pict.....other graphic files
│   ├── soucastky.png
│   ├── spoje.png
│   ├── ZlepseneWilsonovoZrcadloNPN.png
│   └── ZlepseneWilsonovoZrcadloPNP.png
├── text..... $\text{\LaTeX}$  source codes of the text
│   ├── abbreviation.tex
│   ├── appendix.tex
│   ├── bibliography.tex
│   ├── conclusion.tex
│   ├── introduction.tex
│   ├── results.tex
│   └── solution.tex
├── template-thesis.tex..... main file of the thesis
├── template-presentation.tex..... main file of the slides for presentation
└── thesis.sty.....package for typesetting final theses at BUT
```