

TITLE PAGE

Instead of this page, use your personalized titlepage generated by the BUT information system.

ASSIGNMENT

Instead of this page, use your personalized assignment generated by the BUT information system.

ABSTRACT

Abstract in English.

KEYWORDS

Keywords in English

LASTNAME, FirstName. *Title of Student's Thesis*. Semestral Project. Brno: Brno University of Technology, Faculty of Electrical Engineering and Communication, Department of Telecommunications, 2033. Advised by prof. Ing. FirstName LastName, CSc.

Author's Declaration

Author: Bc. FirstName LastName
Author's ID: 007
Paper type: Semestral Project
Academic year: 2032/33
Topic: Title of Student's Thesis

I declare that I have written my thesis independently, under the guidance of the advisor and using exclusively the technical references and other sources of information cited in the thesis and listed in the comprehensive bibliography at the end of the thesis. I have not violated the principles and recommendations of the Brno University of Technology regarding the use of generative artificial intelligence.

As the author, I furthermore declare that, with respect to the creation of this thesis, 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. of the Czech Republic, Section 2, Head VI, Part 4.

Brno
author's signature*

*The author signs only in the printed version.

ACKNOWLEDGEMENT

I would like to thank the advisor of my thesis, Ing. XXX YYY, Ph.D. for his/her valuable comments etc.

Contents

Introduction	23
Aim of the thesis	25
1 Theory	27
2 Thesis Results	29
2.1 Selection of Programming Language	29
2.2 Implementation	29
2.2.1 Tests and Evaluation	29
Conclusion	33
Bibliography	35
Symbols and abbreviations	37
List of appendices	39
A Selected Commands of thesis Package	41
A.1 Quantities and Units	41
A.2 Symbols	41
B Next Appendix	43
C Examples of Listing Computer Codes	45
C.1 Package listings	45
D Algorithms	49
E Content of the electronic attachment	51

List of Figures

B.1	Wilson mirror	43
-----	-------------------------	----

List of Tables

A.1 An overview of commands 41

List of Algorithms

1	B-PHADQ	49
---	-------------------	----

List of Listings

C.1	Example of code listing	45
C.2	Example of the Schur–Cohn test of stability in Matlab	46
C.3	Example of implementation of first canonical form in C	47

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.¹

The template is set to twoside printing by default. Do not be surprised that you find empty pages in your PDF. They are there to make the chapters and other important stuff begin on the right side when the document is printed. Having a serious reason to print one-sided, please switch the option `twoside` to `oneside`!

¹This sentence is only to demonstrate how abbreviations can be used and typeset.

Aim of the thesis

Specification of the objectives to be solved in the thesis. If your study program does not insist on having such a separate chapter with the aims, please specify them as a part of the Introduction.

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 dolore 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 dolore 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] VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ. *Směrnice č. 72/2017, Úprava, odevzdávání a zveřejňování závěrečných prací*. Online. Brno: VUT v Brně, 2017. Úplné znění ke dni 11. 4. 2022. Dostupné z: <https://www.vut.cz/uredni-deska/vnitřni-predpisy-a-dokumenty/smernice-c-72-2017-uprava-odevzdavani-a-zverejnovani-zaverecnych-praci-d161410>. [cit. 2023-09-27].
- [2] ÚŘAD PRO TECHNICKOU NORMALIZACI, METROLOGII A STÁTNÍ ZKUŠEBNICTVÍ. ČSN ISO 690:2022 (01 0197), *Informace a dokumentace – Pravidla pro bibliografické odkazy a citace informačních zdrojů*. Čtvrté vydání. Praha, 2022.
- [3] ÚŘAD PRO TECHNICKOU NORMALIZACI, METROLOGII A STÁTNÍ ZKUŠEBNICTVÍ. ČSN ISO 7144 (010161), *Dokumentace – Formální úprava disertací a podobných dokumentů*. Praha, 1997.
- [4] ÚŘAD PRO TECHNICKOU NORMALIZACI, METROLOGII A STÁTNÍ ZKUŠEBNICTVÍ. ČSN ISO 31-11, *Veličiny a jednotky – část 11: Matematické znaky a značky používané ve fyzikálních vědách a v technice*. Praha, 1999.
- [5] FARKAŠOVÁ, B. et al. *Výklad normy ČSN ISO 690:2022 (01 0197) účinné od 1. 12. 2022*. Online. První vydání. 2023. Dostupné z: <https://www.citace.com/Vyklad-CSN-ISO-690-2022.pdf>. [cit. 2023-09-27].
- [6] *Pravidla českého pravopisu*. 1. vydání. Olomouc: FIN, 1998. ISBN 80-86002-40-3.
- [7] WALTER, G. G. a SHEN, X. *Wavelets and Other Orthogonal Systems*. 2. vydání, Boca Raton: Chapman & Hall/CRC, 2000. 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. a 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.

Symbols 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 45)

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

DSP Digital Signal Processing

f_s sampling frequency

List of appendices

A	Selected Commands of <code>thesis</code> Package	41
A.1	Quantities and Units	41
A.2	Symbols	41
B	Next Appendix	43
C	Examples of Listing Computer Codes	45
C.1	Package listings	45
D	Algorithms	49
E	Content of the electronic attachment	51

A Selected Commands of thesis Package

A.1 Quantities and Units

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

Command	Example	L ^A T _E X code of example	Meaning
<code>\textind{...}</code>	$\beta_{\max}$	<code>\$\beta_{\textind{max}}\$</code>	text-style index
<code>\const{...}</code>	U_{in}	<code>\$\const{U}_{\textind{in}}\$</code>	constant
<code>\var{...}</code>	u_{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`, `\eul` – 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 type¹: μ ,
- `\uppi` – typesets π (greek pi in roman type, in difference to `\pi`, which typesets π).

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

¹the symbol comes from package `textcomp`

B Next Appendix

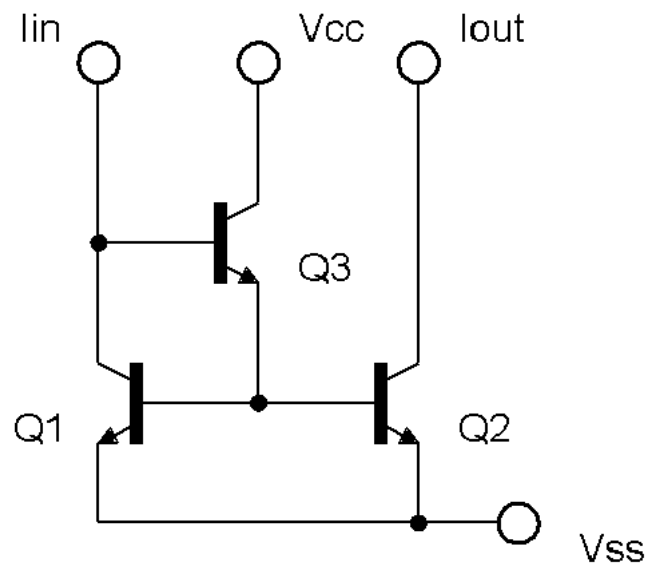


Fig. B.1: Improved Wilson current mirror.

For inclusion of the vector-based graphics directly via L^AT_EX, it is possible to use the `TikZ` package. Examples of use can be found at the T_EXample 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 mez stability');
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 mez stability');
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 Algorithms

For typesetting algorithms/pseudocode, the `algorithm2e` package can be used, offering rich options. Algorithms can be referenced by usual cross-references, as here: see Alg. 1.

Algorithm 1: B-PHADQ

```

Choose parameters  $\tau, \sigma, > 0, \rho \in [0, 1]$ 
Initialize  $x^{(0)}, p^{(0)}, q^{(0)}$  and  $\omega_s$ 
for  $i = 0, 1, \dots$  do
     $q^{(i+1)} = \text{clip}_\lambda(q^{(i)} + \sigma D R_{\omega_s} G_g x)$ 
     $u = p^{(i)} - \tau G_g^* R_{\omega_s}^* D^* q^{(i+1)}$  % auxiliary
     $p^{(i+1)} = \text{proj}_\Gamma(u)$  % consistent
     $p^{(i+1)} = \frac{1}{\tau+1}(\tau \text{proj}_\Gamma(u) + u)$  % inconsistent
     $x^{(i+1)} = p^{(i+1)} + \rho(p^{(i+1)} - p^{(i)})$ 
end
return  $p^{(i+1)}$ 

```

E Content of the electronic attachment

An electronic attachment is often a part of the thesis. The attachment is uploaded in the BUT information system together with the thesis PDF. Please use an appropriate file format for the attachment.

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, what was the setting of the compiler etc. It is also valuable to specify in which version of the software the code has been tested (e.g. Matlab 2018b). In the case that hardware has been created within the thesis, the electronic attachment must contain all documentation (for example Eagle files with the printed circuit board layout).

If your attachment contains a lot of files or folders, L^AT_EX package `dirtree` can become handy, as in the following example.

```
/.....root of the attached archive
├── 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.....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
```