FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

DEGREE PROGRAMME IN ELECTRONICS AND COMMUNICATIONS ENGINEERING or
DEGREE PROGRAMME IN WIRELESS COMMUNICATIONS ENGINEERING

MASTER'S THESIS

MASTER'S THESIS GUIDELINES[1]

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December 2018

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[1] Thesis title

ABSTRACT

These guidelines instruct final-year students in the Degree Programme in Electronics and Communications Engineering OR Degree Programme in Wireless Communications Engineering to write a well-formulated master's thesis. They define the detailed composition for the thesis including writing style, wording, layout and referencing style. The formatting of the guidelines resembles as closely as possible that of an actual thesis.

A Finnish language version of the guidelines has been produced for Finnish students. Most students, regardless of their background, write the thesis in English.

Keywords: master's thesis, guidelines, layout.

TIIVISTELMÄ

Tässä diplomityöohjeessa opastetaan valmistumisvaiheessa olevaa elektroniikan ja tietoliikennetekniikan tutkinto-ohjelmassa opiskelevaa opiskelijaa diplomityön kirjoittamisessa. Ohjeessa määritellään yksityiskohtaisesti diplomityön rakenne, kirjoitus-, kieli- ja ulkoasu (typografia) sekä lähdeviittauskäytäntö. Ohjeen rakenne on tehty mahdollisimman samankaltaisiksi diplomityön kanssa.

Ohjeesta on laadittu myös englanninkielinen versio ulkomaalaisia opiskelijoita varten. He ja useimmat suomalaiset opiskelijat kirjoittavat diplomityön englannin kielellä.

Avainsanat: diplomityö, kirjoitusohje, ulkoasu.

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FOREWORD

These master's thesis guidelines have been produced at the Faculty of Information Technology and Electrical Engineering, the University of Oulu to be used in the Degree Programme in Electronics and Communications Engineering. The main objectives have been to create detailed instructions to assist thesis authors in their writing process and to guarantee a uniform layout and style for theses. Differing from previous guidelines, this updated version focuses uniquely on the structure of the thesis, the layout of its electronic format and on the actual writing process. Issues related the thesis process and graduation are explained on the degree programme website.

Previous thesis writing guidelines, guidelines of the "Acta Universitatis Ouluensis" publication series and the book "Teknisen kirjoituksen laatiminen", where applicable [1, 2], have served as a starting point for the latest guidelines. Numerous individuals have participated in the production of the earlier versions during the past years. The first version was created under the direction of Professor Pentti Lappalainen at the Department of Electrical Engineering already in the 1990's [3]. The instructions were updated and complemented in 2005 and 2010-2011 by the Study Committee of the Department of Electrical and Information Engineering. The Degree Programme Committee of Electrical Engineering furthermore revised the guidelines in autumn 2011.

These guidelines, which have been approved by the Degree Programme Committee in Electronics and Communications Engineering, will be applied to master's theses which are completed after 1 September 2018.

Oulu, 17 August, 2018

Degree Programme Committee

LIST OF ABBREVIATIONS AND SYMBOLS[2]

AGC	automatic gain control
AWGN	additive white Gaussian noise
BER	bit error ratio
SNR	signal-to-noise ratio
B	signal bandwidth
B_d	Doppler spread
b_k	auxiliary variable matrix at instant k
c_0	1$^\text{st}$ tap coefficient of filter
f_d	Doppler frequency
β	shape factor
ε_k	error signal value at instant k
$\Phi_n(t)$	phase of the nth multipath transmitted signal at instant t
$\Phi(t)$	phase of received signal at instant t
σ^2	variance
( )*	imaginary part
arg( )	argument

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[2] These abbreviations and symbols are examples and do not appear in this text. In your thesis, make sure to include all abbreviations and symbols in this section. Note also, that in your text, you must write the full definition first to introduce the concept after which you can use abbreviations.

1   INTRODUCTION

The established scientific method consists of the essential elements which are listed below. The same logic is repeated in scientific publications.

- Define the problem you will explore and solve.
- Collect information and discover the state-of-the-art in the technical field.
- Formulate a suitable hypothesis on the basis of the information.
- Utilize the hypothesis to plan experiments and to predict their outcomes. This phase is very important as a researcher must have a prevision on the results he or she is about to get and what should be interpreted based on them.
- Perform experiments and collect data. Importantly, your experiments must produce results, which enable reliable and confident interpretation of the aspired factors.
- Analyse in an honest manner the data you have collected.
- Interpret and draw conclusions, approve, reject or reformulate your original hypothesis.
- Publish the results and accept the criticism that they may raise.

Technical documents do not usually follow the general pattern of the scientific method. Instead, they are produced to depict unequivocally the operation or implementation of a device to another person with similar technical knowledge. A report of this type may be extremely detailed.

A technical thesis is positioned in the middle ground of these two document types. Most often, a thesis is a technical document created in the spirit of the scientific method. Therefore, it includes a wider description of the background and theory. An adequate number of conclusions must also be presented based on the results. It is not necessary to portray all phases and results in detail. You should rather focus on the key findings and explain them.

Typically, a thesis includes two parts: implementation (literature review, device construction, software, measurements) and discussion of the results. Implementation depends on the problem to be solved and thus general guidelines cannot be given. However, each publication series has its dedicated layout which must be adopted in all works. These guidelines focus on the established practice of the Degree Programme in Electronics and Communications Engineering at the University of Oulu. The print layout has an impact on readability and therefore students are expected to follow carefully the guidelines. In this manner, the author may also learn a good writing style. Later on, this experience will facilitate the adoption of written communication practices in each place of employment.

These guidelines consist of seven chapters in addition to the introduction. In chapter two, the structure of the master's thesis is discussed including the items which are typically presented in each section. In chapter three, the layout and formatting of the text is examined as well as the positioning of figures and tables. In chapter four, the wording in the thesis is briefly discussed. In chapter five, practical advice are given to smoothen the writing process. Chapter six includes the conclusion and the last two chapters cover references and appendices.

2   THESIS STRUCTURE

A master's thesis is typically composed of the following sections:

- title page
- abstract
- tiivistelmä[3]
- table of contents
- foreword
- list of abbreviations and symbols
- introduction (chapter 1)
- core (chapters 2…n), where n signifies the last chapter focusing on the core
- discussion (chapter n+1)
- summary (chapter n+2)
- references (chapter n+3)
- appendices (chapter n+4).

Next, each of these sections are discussed in detail.

2.1   Title page

A standard format is used for the title page and the placeholder texts must be replaced with details of the thesis in question. If the thesis is written in English, the text elements on the title page must be in English.

2.2   Abstract

The abstract serves the purposes of data transfer and data search in **information systems**. It clarifies the content of the thesis for the reader in a condensed format. The abstract is an **independent** presentation, which must be understandable without additional text. Hence, it cannot include any references to the other parts of the thesis, nor any information which is not discussed in other thesis chapters. The abstract defines the topic area of the thesis, the essential content, achieved results and conclusions. The abstract should not be longer than 200 words. Use of rare terms or abbreviations must be avoided.

On the top of the abstract page, the bibliographic information of the work must be added. Under the abstract text, the author adds keywords. Their recommended amount is 2–6 words or multi-word expressions. Keywords should not repeat any words in the thesis title. Both the title and the key words will be used in online literature searches.

2.3   Tiivistelmä

"*Tiivistelmä*" is the Finnish translation of your abstract. It must be written in fluent, error-free Finnish. In a thesis written in English, abstract precedes "*tiivistelmä*" and vice versa.

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[3] Your abstract translated into error-free Finnish

2.4   Table of contents

In the table of contents, all chapter headings and subheadings of the thesis are presented with their respective page numbers. **Headings** in the first part of the thesis (abstract, table of contents, foreword, list of abbreviations and symbols) are not numbered. Numbering begins from the heading "Introduction". Title page is the first page of the thesis. **Page number** appears for the first time on the page following the Introduction page(s) (or equivalent). Arabic numerals in the upper right corner are used for page numbering. If the thesis is written utilizing the provided Word template, it contains the automated generation feature of the table of contents.

2.5   Foreword

The foreword clarifies the objectives of the thesis, essential phases of the research work and names of the organisations which have provided support for the research. The foreword also includes possible acknowledgements for other researchers, assisting personnel and financial sponsors of the research.

2.6   List of abbreviations and symbols

The abbreviations of terms, variables and measurement units as well as the definitions of other symbols are given as a single list in alphabetical order. **Accuracy** of the definitions must be verified from standards and other relevant sources. The internationally approved SI-system is utilised in the thesis work [4]. Definitions must also be provided in the text when the term appears for the first time.

In the list, define first the abbreviations, then mathematical and other symbols and last letter symbols so that Latin, Greek and other letters are each presented in their designated groups.

2.7   Introduction

In the introduction, you should present briefly and clearly the background and motivation for your work, guide the reader to the research problem, and explain the chosen scope, detailed objectives and methodology of the work. If needed, you can also refer to previous research in the field or state-of-the-art research. You should not discuss any results of your work in the introduction.

Currently, master's theses are often integrated in the research work carried out in research groups or research and development (R&D) units. Hence, the reader may have difficulties in understanding when you are referring to your own work and when the work has been realized by a group of 20 people. In order to avoid confusion, you must clarify in your introduction, with sufficient accuracy, your exact role in the research work or project. At the end of the introduction chapter, you may also include a glance on the structure of your thesis.

2.8   Core

The content and organization of the core part of your thesis depends essentially on the nature of your work. In many theses, the author first describes the scientific environment, objectives and boundary conditions (typically in 1-2 separate chapters) with an accuracy which is sufficient to provide grounds and make understandable the choices introduced later in the work. The first part of the core may also include a description of alternative solutions and their analysis for instance utilizing system-level modeling. It is also possible to refer to relevant solutions portrayed in literature keeping in mind that the discussion on them should not be too extensive. A theoretical approach on the given topic can become a natural element in some theses where the student presents, based on his on her own prior knowledge or referring to literature, the theoretical grounds on which the thesis work relies. However, unnecessary wordiness must be avoided and as a result the theory presented must be directly linked to the realised work. It is noteworthy, that many theses do not include a theoretical section of any type. **Hence, you should not insist on adding theory if it does not fit in naturally**.

In the possible presentation of related theory, mathematical equations and denotations often have a major role. However, it is important to keep in mind that mathematics is a tool for technical writing – not a main purpose. Therefore, introducing all details with a mathematical equation is unnecessary. It is sufficient to present the basic equations, needed variables and the end results. If needed, the full derivation can be added to the thesis as an appendix. In science and technology, two types of equations are employed:

- equations between quantities where letter symbols represent physical quantities, and
- equations between numerical values where letter symbols represent the numerical values of the variables.

A quantity is the product of the numerical value and the unit of measure. The unit of measure must always be separated from the preceding numerical value with a space (e.g. 5 °C, yet 5°). Equations between quantities are recommended because they are not dependent on the choice of units of measure unlike equations between numerical values. Calculations with quantities follow the rules of algebra and the utilized symbols are typically single letters. The mathematical variables and symbols of quantities must be italicized, i.e. written in italics. Vectors must be italicized and boldfaced. Numbers, units of measure and subscripts are not italicized (subscripts, which are symbols of quantities, are italicized). Greek letters are not italicized either. Each equation must be an element in a complete sentence. An empty row must be added above and below an equation which are numbered in an increasing order through the entire text or alternatively by chapter, if there are large quantities of equations. The corresponding order number is placed in parentheses on the right side of the equation. References to equations in the text are made with the order number of the equation in parentheses. In steady movement, speed v is

$$v = \frac{s}{t}, \tag{1}$$

where s is the distance and t the time travelled. The implications of equation (1), in turn, are…

Following the first sections of your thesis, your individual contribution will be presented, although parts of it may also be included in the preceding sections. Typically, you proceed with your topic by first introducing the implementation – device construction, electronic circuit, measurement solution, manufacturing method or similar – together with the rationale and

justifications for the chosen solutions. Next, you can present measurement or simulation results, among others, as well as observations aimed at clarifying the functionality of the implementation. In order to make the observations useful for others, the details of the implementation work must be described accurately and the observed results must be presented in their original format (for instance in a table). Special attention must be paid to keeping actual results and own estimates separate. In addition, it must be clarified which data results from simulations and which is produced by measurements.

In a thesis based on a construction or software, the solution is expected to be approached with the means of system planning. Only the essential details, which are of importance for the built device or software, should be given on basic theory and the construction. The exact structure of a device or software can be illustrated in the appendices, if needed. The functionalities of the system are described section by section starting from the largest level towards smaller ones. When introducing electronic circuits and software structures, you must avoid excessive details. However, in the thesis core, it is justified to present especially such relevant circuit-level structures, which are not self-evident even to experts.

Measurements are intrinsically related to theses which present constructions and therefore they must be carefully planned. The same is valid for the testing of software solutions. Yet, the thesis is not a measurement report and hence it is unnecessary to introduce all the results. Consequently, each presented figure must have a clear significance.

2.9   Discussion

A good master's thesis, similar to other scientific work, always includes a discussion section allowing the observation of the results. To succeed in the writing of the discussion chapter, it is essential to take sort of distance from one's own work – to critically analyse and compare the work to other works in the same research field which results in crystallising one's own scientific contribution. This task is difficult even for an experienced writer, but profound knowledge of one's own field as well as the state-of-the-art research and development work within that field are helpful.

In this section, the author can present his or her own evaluation and grounds on meeting the set objectives. It is also possible to introduce estimates of the more general importance of the work as well as comparisons to other published research and development work in the same field. In addition, further possibilities to elaborate the work can be discussed, especially if new ideas on possible approaches have emerged during the thesis work. However, unnecessary speculation must again be avoided and one should focus on justifiable estimates.

2.10 Summary

The summary is a condensed and clear recapitulation covering the objectives of the research/work, essential content, final results and their meaning. Special attention must be paid to the outcomes resulting from one's own research contribution. No references to other sections or chapters should be made in the summary, and no results should be presented which do not appear elsewhere in the text.

Hence, the summary and abstract partially overlap, but their core is the same – description of the content and results of the work. However, the summary is wider and, in addition to the previous, it presents the objectives of the work and it may also include descriptions of

alternative solutions, motivation for the chosen solution and its description with more details than in the abstract.

2.11 References

The use of references serves multiple purposes. The scientific method relies on in-depth study of the topic and exploration of the state of the art in technology. Yet, in the literature review it is only possible to focus on the most important results because details can be discovered via references. Therefore, references are a means to shorten and condense the text.

The literature review should be as exhaustive as possible which commonly results in a theory section consisting entirely of borrowed information. If the information presented does not derive from one's own reflection and is not the work of one's own hands, it is borrowed and hence the source of information must always be indicated with an attribution. Presenting borrowed information as one's own production is scientific plagiarism which has causes very serious sanctions.

In the references chapter, one must always refer to original sources (e.g. a book and not the lecture notes which are based on it) and only to sources which one is thoroughly conversant with – the presented information must truly appear is the referenced source.

In technology, the content in source material is mostly described with own words. If the exact wording in the source merits emphasis, the citation is given in quotation marks e.g. as follows. The exact translation of Moore's law is of form "The complexity for minimum component costs has increased at a rate of roughly a factor of two per year [x]."

Sources are numbered in increasing order and listed in the order in which they appear in the text. Author's last name comes first followed by the initials of given name and middle name. In the text, a reference to the references chapter is made with the reference number, e.g. [1] or [1, 2, 5]. When the reference relates to the content of a single sentence, the reference is added to the end of the sentence in question prior to the period. On the other hand, when the reference concerns the information is a full paragraph, the reference is placed at the end the paragraph after the period of its final sentence. In order to refer to a specific page or pages in the source, the formatting is [1 p. 14] or [1 pp. 14–15]. References must be given in such a clear manner that the reader will be able to distinguish which information derives from a source and which information, on the contrary, is produced by the author. Furthermore, the source of borrowed sentences, equations and figures must always be indicated. Online publications must be use cautiously as the content available in the internet changes quickly and therefore the actual date of citing a specific webpage must be stated. In some cases it is possible to utilize the DOI (Digital Object Identifier) reference which enables the locating of the publication in the internet without knowing the corresponding URL.

Acronyms are written in capital letters regardless of the spelling of the full definition. Periods are used in acronyms. Use of foreign language acronyms is not recommended. The name of the publication must be listed its original language of publication. The structure of references depending on the publication type as well as the use of punctuation is best illustrated in the following examples:

Series:

[1] Kostamovaara J. (1986) Techniques and Devices for Positron Lifetime Measurement and Time-of-Flight Laser Rangefinding. Acta Universitatis Ouluensis, Series C, Technica 37. Oulun yliopisto, Oulu.

Journal:

[2] Arai Y. & Oshugi T. (1989) TMC-A CMOS Time to Digital Converter VLSI. IEEE Transactions on Nuclear Science 36, p. 528–531.

A section in compiled work:

[3] Gajski D. (1991) Essential Issues and Possible Solutions in High-Level Synthesis. In: Camposano R. & Wolf W. (toim.) High-Level VLSI Synthesis. Kluwer Academic Publishers, Boston, Mass., p. 1–26.[4]

Book:

[4] Hakalahti H., Lappalainen P. & Tervonen M. (1978) Minitietokoneet: Rakenne, ohjelmointi, prosessiliitännät. Sähköinsinöörikilta ry, Oulu, 431 p.

Conference proceedings:

[5] Mitra S.K. (1991) Some Unconventional Signal Processing Applications of Multirate Techniques. In: IEEE International Symposium on Circuits and Systems, June 11–14, Raffles City, Singapore, Vol. 1, p. 13–16, New York.

Unknown author:

[6] Asumistaso: asuntoasian vuosikirja (1991). Suomen Asuntoliitto, Helsinki, 72 p.

Thesis:

[7] Kurikka P. (1992) Tietokoneavusteisen elektroniikkasuunnittelun kehitysjärjestelmien vertailu ja arviointi. Diplomityö. Oulun yliopisto, sähkö- ja tietotekniikan osasto, Oulu.

Online publication:

[8] Krishnan V. & Torrealis J. (read 22.10.1999) A Chip-Multiprosessor Architecture with Speculative Multithreading. URL: http://computer.org/tc/tc1999/ t0866abs.htm.

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[4] If page numbering is made by chapter, use the format: p. 3-1 ... 3-2.

2.12 Appendices

Appendices may include derivations of equations, important software and tables as well as performance figures and brochures of special components and equipment utilized in the work. Furthermore, important construction drawings and catalogues of parts can be added as appendices. Appendices are titled following the model on page 23. A large number of appendices is not an end in itself, and thus all appendices are expected to add meaning for the realized work.

If the text explains a lot of information which is presented in an appendix, it is better to copy the information to the actual text as a figure or a table. In this manner, the laborious browsing between the text and appendices, which makes reading cumbersome, can be avoided.

If an appendix presents for instance a large circuit or block diagram, it can be decreased to fit the size of a page provided that the resolution is good. It is always possible to enlarge an electronic document when necessary. If a bound hard cover version of the master's thesis is targeted, it is sensible to divide a large picture into parts and place them on two or several pages. In all cases, it is essential to ensure that the appendices, as well as all other figures, are legible. If this is not the case, the appendices and figure lose their importance.

3   FORMATTING THE TEXT LAYOUT

The following setting and guidelines must followed in formatting the text layout.

- Font: Times New Roman
- Page margins:
  - Left: 2.5 cm
  - Right: 2.5 cm
  - Top: 2.5 cm
  - Bottom: 3.0 cm
- Spacing:
  - Before a heading: 2 empty rows
  - After a heading: 1 empty row
  - Between two headings: 1 empty row
  - Between two lines: single line spacing which is set as default for each font size, usually the font size + 2 pt
  - The space between two paragraphs is a normal line spacing
  - There is no indent in the first paragraph following a heading, but the following paragraphs are indented by 0.5 cm
  - A single empty line is added between table and figure captions and the basic text
- The structure of a table and typefaces used in different cases are introduced in table 1.
- The heading of a table is placed above the table. There is no period after the heading nor an empty row between the heading and the table. It is possible to align the table and its heading either to the left or to the center of the page depending on the size of the table.

Table 1. Typefaces to be utilized in a master's thesis

Font size (p.)	Layout			
	Regular	**Bold**	*Italic*	***Bold italic***
10	superscript and subscript			
12	basic text, equations, references, tables, captions, table heading	**first level heading, abstract, tiivistelmä**	*third level subheading*	***second level subheading***
14	AUTHOR'S NAME	**CHAPTER TITLE[5]**		
18		**MASTER'S THESIS TITLE**		

- A figure caption is placed under the figure and it is followed by a period. If needed, the caption can be separated from the figure with a single line spacing to for reasons of clarity. A figure and a short caption can be centered on the page. A figure and a long caption are justified at both ends.

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[5]   Each chapter of this type begins on a new page.

- If a figure is composed of several elements, it must be formatted as introduced in figure 1.
- Figure captions and table texts should not include any references. Instead, references are presented in that part of text which refers to the figure or table.
- A figure should never start a paragraph, but should always be placed within text. A figure must always be preceded by its reference.

A subheading should never be used on its own – for instance subheading 2.1 needs to be accompanied at least by subheading 2.2. The maximal number of subheading levels is three, e.g. 2.1.1. If there is a need for further levels, a bolded unnumbered heading can be used:

Formatting of figure captions and table texts

Figures, tables and appendices are part of the written presentation. References must be given for each of them in their order of appearance, preferably preceding them – first the reference and then the figure. Figure and tables are numbered in an increasing order through the entire text or alternatively by chapter if they are numerous.

Figure 1 serves as an example of a figure and its reference. The figure caption is placed under the figure and it ends with a period. A short figure caption is centered and a long one taking several rows is justified from both ends. Following copyright law and regulations a permission must always be asked from the owner of the copyright in order to publish the figure. Therefore, in the thesis work the author should primarily use figures produced by himself or herself.

(a) Horizontal logo   (b) Vertical logo

Figure 1. Horizontal and vertical logos of the University of Oulu.

If an author wishes to make a bound, hard cover version of a master's thesis which is in electronic format, he or she should ask the printing service to prepare the layout as the format requires.

4   WORDING

A person having completed the Finnish matriculation examination writes the master's thesis in Finnish or Swedish. Foreign students, students writing their thesis abroad and students supervised by non-Finnish speakers can write their master's theses in English. In other cases, the right to utilise English must be requested in writing at the same time with the application for Master's Thesis topic (Appendix 1). Regardless of the language, the thesis must have a title and an abstract both in Finnish and in English (see chapters on Abstract and Tiivistelmä).

In a thesis written in English, abstract precedes Tiivistelmä. It is recommended that native Finnish speakers write the thesis in Finnish. Producing a good presentation in one's native language is a demanding task, not to speak of writing in English. It should be kept in mind that wording is also evaluated and clarity is an important evaluation criterion.

The thesis is written for readers with an engineering training background. Thus, presenting unnecessarily details, which are already familiar to the audience, should be avoided. Furthermore, the author should not discuss topics that he or she does not master. Established **professional terminology** is expected to the utilised in the thesis, when it exists. The same rule applies for figures and drawings.

The writing should aim at clarity and a well-structured approach, which requires avoidance of excessive wordiness. The writing must be fluent and readable following the established linguistic norms and conventions of the language is question. For instance, in a Finnish language text, decimal fractions are separated with a comma whereas in English by a period.

The wording of a thesis written in English must likewise be refined. If the student is not fluent in English or the supervisor perceives that he or she is unable to evaluate the wording, the supervisor has the possibility to require proofreading by an official translation agency, by a native English speaker who is familiar with technical terminology, or by a university graduate with an English major. The student's task is to acquire a certificate of the proofreading to be handed for the supervisor.

If the thesis is written in English following the demand by the contractor, the latter should be prepared to cover the costs of proofreading.

5 PRACTICAL ADVICE FOR THE WRITING

Writing the master's thesis usually necessitates approximately two or three months – one page of polished text is normally produced in a day. Naturally, the work can be written in a shorter time, but creating both the structure and the refined text takes its time. Next, some practical advice are given which are aimed at facilitating especially the initiation of the writing, which is most often the most difficult phase in the writing process, as experience has shown.

5.1 Explore master's theses written by other students

Before you start to plan the structure and content of your master's thesis, explore some master's theses produced by others, at the minimum at a glance. This will give you a good feeling of how others have dealt with their topics and will help you in discovering a suitable manner of approaching and presenting your topic.

5.2 Do not postpone writing

Implementing the work and writing side by side force you to structure your approach which often leads to novel discoveries. Hence, a number of later corrections can be avoided. Start at least outlining the literary structure and acquiring and investigating source material at an early phase, although the actual writing work would remain towards the end of the thesis writing period.

5.3 Discuss with your supervisor before starting to write

It is in the supervisor's interest to ensure that the student graduates as fast as possible and without great difficulties. Therefore, he or she has a strong motivation to solve arising problems at an early stage. A typical problem in the starting phase to be corrected is the table of contents where the theory and practice (or simulations and testing) are clearly divided into two. Such a structure leads to repetition and complicates the writing overall.

Therefore, start the writing by drafting a table of contents which serves at the same time as a framework for the writing. Often, it is beneficial to define the headings for chapters $1-n$ (introduction and the core) and outline their essential content with a few words before beginning the actual writing. Each subheading can be seen to have a certain "message" you wish to convey for the reader. Your task is to crystallize this message and subsequently write in a fluent and understandable format. Such prior reflection gives confidence that one can survive the writing process and thus diminishes considerably creation anxiety.

5.4 Write in the actual order

For most students, writing the chapters in the order they will appear is most suitable. Beginning with the introduction is sensible, because the objectives and content of the work are also defined first. Thus, the introduction sort of limits the topic and subject area and sets the borders for what will be discussed in the thesis. The other chapters in the first part of the book, which usually

present the application environment, possible theoretical basis and so forth, can also be written relatively early on. Familiarising with the source material is usually related to them which is another reason to start documenting right away, when things are still fresh in mind.

5.5   Aim for simplicity

The first sentence in a paragraph defines its content. The following sentences further specify the matter. This structure leads to a clear and easily understandable presentation where each chapter consists of information on merely one or two issues. This type of chapters can moved to a later section without difficulty if the structure must be modified later. To avoid fragmentation, it is important not to discuss the same issue in several places. The reader finds is easy to follow the logic as long as it is consistent and at the same level of abstraction as the text. Thus, do not try to be too elaborate, but present the issue as you would like to hear it or read it yourself.

5.6   Ask feedback from your supervisor and technical adviser

Often the technical advisor and supervisor are different individuals, especially in thesis produced in collaboration with industry. In such a case, comments should be asked from the technical advisor working in industry and corrections should be make following his or her instructions before handing the thesis for the supervisor. The technical adviser, who follows the progress almost on a daily basis, is bound to give feedback much more rapidly and furthermore a more polished work gives a better impression for the supervisor. It is highly beneficial to utilize the experience of a technical adviser from industry in all the phases of the writing work. Nevertheless, do not hesitate to show your work for your supervisor in the early stages of the writing (see chapter 5.3 above), as he or she truly knows the requirements for a master's thesis and evaluates your work with the second reviewer.

It is easy to become blind for one's own text which leads to presentation of novel issues as so self-evident that a non-expert reader cannot follow. An outsider notes this most easily. Often, one can distinguish this phenomenon in one's own text only by focusing intensively or by reading the text again after a few days.

5.7   Avoid stagnation

Figure 2 illustrates the type of anguish writing may cause. If writing is not progressing although you are well aware of your topic, your working habits may be erroneous. Do not waste any time in a state of stagnation, but seek for help in the guidelines given above. If they do not help, contact the supervisor who is usually capable of solving the problem fast. At the most difficult moment of the writing work, it is worth keeping in mind that each individual, who has graduated from the degree programme in electrical and communications engineering (former name), has been able to write his or her own thesis.
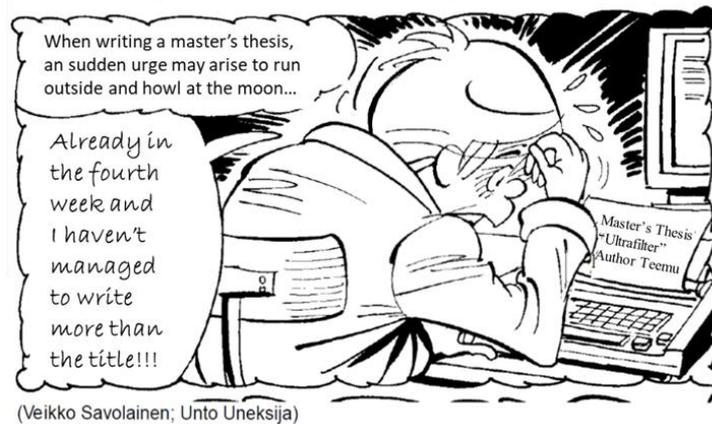
Figure 2. The difficulty and anguish of writing.

5.8   Instructions for text editing

A well-prepared text template, where the formatting of different types of paragrahps has been pre-defined, facilitates the thesis writing greatly. Also automatic numbering and use of references saves a lot of manual work if the order of presentation changes.

Most word processing programmes provide a proofing functionality, which is advisable to use also when writing in a foreign language. Thus, the supervisor can focus on checking the actual content and put less effort on finding spelling mistakes.

5.9   Electronic version

University of Oulu utilises Urkund, a program for checking of references and preventing plagiarism, as well as an electronic archiving system of theses. The copyright of the thesis belongs to the author, but the University strongly recommends that the student should grant the right for both electronic archiving and for checking the work with Urkund. The electronic pdf-version of the master's thesis, produced following the master's thesis guidelines, is suitable for this purpose.

6 SUMMARY

These master's thesis guidelines have described issues concerning master's thesis writing. The structure and layout of the thesis, wording as well as practice of referencing have been discussed. The guidelines have also provided numerous practical hints for facilitating the writing work. The layout of these guidelines resembles an actual master's thesis so that it illustrates the appearance of a finalised thesis.

7   REFERENCES

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[4]   SI-opas: suureet ja yksiköt, SI-mittayksikköjärjestelmä (Système international d´unitès) (1974). Suomen standardisoimisliitto, Vakaustoimisto, Helsinki, 23 p.

8   APPENDICES

Appendix 1   Application for master's thesis topic

Appendix 1   Application for master's thesis topic

UNIVERSITY OF OULU

FACULTY OF INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING

APPLICATION FOR MASTER'S THESIS TOPIC

Name of student: _____

Student number: _____

Telephone & e-mail: _____

Degree programme: _____

Specialisation option: _____

Year of enrolment: _____

Credit units: _____

Remaining mandatory courses:

_____

_____

Thesis workplace (i.e. the customer):

_____

I apply for the following topic:

Finnish: _____

_____

English: _____

_____

Thesis is written in: Finnish   English

The costs of English language revision, if needed, are covered by

Employer   Worker

Proposed supervisor at the university: _____

Proposed second examiner / reviewer: _____

Proposed technical supervisor (if needed)[6]: _____

Date   ___/___ 20__   _____
                                Signature of student

Date   ___/___ 20__   _____
                                Signature of supervisor

Accepted   ___/___ 20__   _____
                                Head of degree programme

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[6] The technical advisor does not need to be specified, but filling this field is recommended specifically when a university researcher participates in supervising the work or technical supervision is given by the employer's representative.

MASTER'S THESIS SUPERVISION AGREEMENT   **ENCLOSURE 1**

Name of student: _____

Supervisor at the university: _____

Expected results (e.g. a device, piece of software or method developed mainly by the thesis worker):

_____

_____

_____

_____

CHECK POINT   TARGET (min 4 time):

1. Date ___/___20__ _____

2. Date ___/___20__ _____

3. Date ___/___20__ _____

4. Date ___/___20__ _____

5. Date ___/___20__ _____

6. Date ___/___20__ _____

(E.g. Target 1: Preliminary confirmation of plan and timetable, Target 2: Review of content and table of contents, Target 3. Revision and control of the first version, Target 4. Revision of the last version, preliminary assessment of Work and "Laturi" Instructions for upload, Target 5. Feedback discussion)