How to Write a Thesis?

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Abstract

This report is intended for students of the Division of Applied Mathematics at the School of Education, Culture and Communication of the Mälardalen University, who write bachelor or master theses. We determine recommendations to the structure of a thesis and give some useful advices.
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Introduction

Experience shows that many students do not know standard rules of writing bachelor and master theses. In this report, we try to assemble all necessary rules as well as some other useful hints.

In Chapter 1, we give an English translation of the requirements of the Swedish National Agency for Higher Education (in Swedish: Högskoleverket) to Bachelor, Magister, and Master theses in mathematics, mathematical statistics, financial mathematics and actuarial science.

In Chapter 2, we give recommendations covering the contents of a thesis item by item, and give detailed explanations concerning each item.

In Chapter 3, we collected useful advices concerning tables, figures, and formulas in your thesis.

Experience shows that many students have trouble with correct pronunciation of the names of Greek letters in mathematical formulas. In Appendix A, we provide the names of all Greek letters.

Though almost all students use Microsoft Word for report creation, there exist other tools to do that. In our humble opinion, the best of them is \LaTeX. Therefore, in Appendix B we give some useful information for the beginners in \LaTeX.

Please send your remarks by e-mail to the corresponding author to \texttt{anatoliy.malyarenko@mdh.se}.
Chapter 1

The requirements

In this Chapter, we give an English translation of the requirements of the Swedish National Agency for Higher Education (in Swedish: Högskoleverket) to Bachelor and Master theses in mathematics, mathematical statistics, financial mathematics and actuarial science.

1.1 Bachelor degree: mathematics, mathematical statistics, financial mathematics and actuarial science — objectives and criteria

The requirements of the Swedish National Agency for Higher Education to Bachelor theses are shown below (translated from Swedish by Sergei Silvestrov).

Objective 1: for Bachelor degree, student should demonstrate knowledge and understanding in the major field of study, including knowledge of the field’s scientific basis, knowledge of applicable methods in the field, specialisation in some part of the field and orientation in current research questions.

- **Criteria for insufficient goal fulfillment**: the documentation for evaluation indicates that student shows
  - lack of knowledge about the scientific basis of the major field of study;
  - lack of knowledge of applicable methods;
  - lack of deeper knowledge of some part of the major field of study;
  - lack of awareness/orientation of current research questions/issues.

- **Criteria for high goal fulfillment**: the documentation for evaluation indicates that student shows
  - knowledge of the scientific basis of the major field of study;
  - knowledge of applicable methods;
  - deeper knowledge of some part of the major field of study;
  - awareness/orientation of current research questions/issues.
• Criteria for very high goal fulfillment: the documentation for evaluation indicates that student shows
  – significant knowledge of the scientific basis of the major field of study;
  – significant knowledge of applicable methods;
  – significantly deeper knowledge of some part of the major field of study;
  – significant awareness/orientation of current research questions/issues.

Objective 2: For Bachelor degree, the student should demonstrate the ability to search, collect, evaluate and critically interpret relevant information in a problem formulation and to critically discuss phenomena, problem formulations and situations.

• Criteria for insufficient goal fulfillment: the documentation for evaluation indicates that student shows
  – lack of ability to search, collect, evaluate and critically interpret relevant information in a problem formulation;
  – lack of ability to analyse phenomena, problem formulations and situations.

• Criteria for high goal fulfillment: the documentation for evaluation indicates that student shows
  – the ability to search, collect, evaluate and critically interpret relevant information in a problem formulation;
  – ability to analyse phenomena, problem formulations and situations.

• Criteria for very high goal fulfillment: the documentation for evaluation indicates that student shows
  – significant ability to search, collect, evaluate and critically interpret relevant information in a problem formulation;
  – significant ability to analyse phenomena, problem formulations and situations.

Objective 3: For Bachelor degree, the student should demonstrate the ability to independently identify, formulate and solve problems and to perform tasks within specified time frames.

• Criteria for insufficient goal fulfillment: the documentation for evaluation indicates that student shows
  – lack of ability to identify, formulate and solve problems;
  – lack of ability to perform tasks within specified time frames.

• Criteria for high goal fulfillment: the documentation for evaluation indicates that student shows
  – the ability to identify, formulate and solve problems;
  – ability to perform tasks within specified time frames.
• **Criteria for very high goal fulfillment**: the documentation for evaluation indicates that student shows
  – significant ability to identify, formulate and solve problems;
  – significant ability to perform tasks within specified time frames.

**Objective 4:** For Bachelor degree, the student should demonstrate the ability to present orally and in writing and discuss information, problems and solutions in dialogue with different groups.

• **Criteria for insufficient goal fulfillment**: the documentation for evaluation indicates that student shows
  – lack of ability to present orally and discuss information, problems and solutions in dialogue with different groups;
  – lack of ability to present in writing and discuss information, problems and solutions with different groups.

• **Criteria for high goal fulfillment**: the documentation for evaluation indicates that student shows
  – ability to present orally and discuss information, problems and solutions in dialogue with different groups;
  – ability to present in writing and discuss information, problems and solutions with different groups.

• **Criteria for very high goal fulfillment**: the documentation for evaluation indicates that student shows
  – significant ability to present orally and discuss information, problems and solutions in dialogue with different groups;
  – significant ability to present in writing and discuss information, problems and solutions with different groups.

**Objective 6:** For Bachelor degree, student should demonstrate ability in the major field of study make judgments with respect to scientific, societal and ethical aspects.

• **Criteria for insufficient goal fulfillment**: the documentation for evaluation indicates that student shows
  – lack of ability to make judgments in the major field of study with reference to relevant scientific aspects;
  – lack of ability to make assessments in the major field of study by relevant societal aspects;
  – lack of ability to make assessments in the major field of study taking into account relevant ethical issues.

• **Criteria for high goal fulfillment**: the documentation for evaluation indicates that student shows
– ability to make assessments in the major field of study of relevant scientific aspects;
– ability to make assessments in the major field of study by relevant societal aspects;
– ability to make assessments in the major field of study taking into account relevant ethical issues.

- **Criteria for very high goal fulfillment**: the documentation for evaluation indicates that student shows

– significant ability to make assessments in the major field of study of relevant scientific aspects;
– significant ability to make assessments in the major field of study by relevant societal aspects;
– significant ability to make assessments in the major field of study taking into account relevant ethical issues.

### 1.2 Master degree, one year, Master thesis 15 hp

Objective 1: For the Master degree, one year, the students should demonstrate knowledge and understanding in their main field of study, including an overview of the field and deeper knowledge of certain parts of the field and understanding of current research and development work.

Objective 2: For the Master degree, one year, the students should demonstrate deeper methodological knowledge in the major field of study.

Objective 3: For the Master degree, one year, the students should demonstrate the ability to integrate knowledge and to analyse, assess and deal with complex phenomena, questions and situations even with limited information. Objective 4: For the Master degree, one year, students should demonstrate the ability to independently identify and formulate questions and to plan and with adequate methods carry out advanced tasks within specified time frames.

Objective 5: For the Master degree, one year, the students should demonstrate ability orally and in writing to present and discuss their conclusions and the knowledge and arguments behind them, in dialogue with different groups.

Objective 6: For the Master degree, one year, the students should demonstrate ability in the major field of study make judgments taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical issues in research and development work.
1.3 Master degree (2 years): mathematics, mathematical statistics, financial mathematics and actuarial science — objectives and criteria

The requirements of the Swedish National Agency for Higher Education to Master theses (2 years) are shown below (translated from Swedish by Sergei Silvestrov).

**Objective 1:** For Master degree, student should demonstrate knowledge and understanding in the major field of study, including both broad knowledge in the field and substantially deeper knowledge of certain parts of the area as well as insight into current research and development.

- **Criteria for insufficient goal fulfillment:** the documentation for evaluation indicates that student shows
  - lack of broad knowledge in the major field of study;
  - lack of specialised knowledge in certain parts of the major field of study;
  - lack of insight into current research and development.

- **Criteria for high goal fulfillment:** the documentation for evaluation indicates that student shows
  - broad knowledge of the major field of study;
  - deeper knowledge of certain parts of the major field of study;
  - insight into current research and development.

- **Criteria for very high goal fulfillment:** the documentation for evaluation indicates that student shows
  - very broad knowledge of the major field of study;
  - substantially deeper knowledge of some parts of the major field of study;
  - in-depth insight into current research and development.

**Objective 2:** For Master Degree, student should demonstrate deeper methodological knowledge in the major field of study.

- **Criteria for insufficient goal fulfillment:** the documentation for evaluation indicates that the student did not show deeper methodological knowledge in the major field of study.

- **Criteria for high goal fulfillment:** the documentation for evaluation indicates that the student shows deeper methodological knowledge in the major field of study.

- **Criteria for very high goal fulfillment:** the documentation for evaluation indicates that student shows significantly deeper methodological knowledge in the major field of study.
Objective 3: For Master degree, student should demonstrate the ability to critically and systematically integrate knowledge and to analyse, assess and deal with complex phenomena, issues and situations even with limited information.

- **Criteria for insufficient goal fulfillment:** the documentation for evaluation indicates that student shows
  - lack of broad knowledge in the major field of study;
  - lack of specialised knowledge in certain parts of the major field of study;
  - lack of insight into current research and development.

- **Criteria for high goal fulfillment:** the documentation for evaluation indicates that student shows
  - broad knowledge of the major field of study;
  - deeper knowledge of certain parts of the major field of study;
  - insight into current research and development.

- **Criteria for very high goal fulfillment:** the documentation for evaluation indicates that student shows
  - very broad knowledge of the major field of study;
  - substantially deeper knowledge of some parts of the major field of study;
  - in-depth insight into current research and development.

Objective 4: For Master degree, student should demonstrate the ability to critically, independently and creatively identify and formulate issues and to plan and carry out advanced tasks within specified time frames, thereby contributing to the development of knowledge and to evaluate this work.

- **Criteria for insufficient goal fulfillment:** the documentation for evaluation indicates that student shows
  - lack of ability to critically, independently and creatively identify and formulate questions;
  - lack of ability to plan and carry out advanced tasks and thereby contribute to the development of knowledge and inability to evaluate this work;
  - lack of ability to implement the above within specified time frame.

- **Criteria for high goal fulfillment:** the documentation for evaluation indicates that student shows
  - the ability to critically, independently and creatively identify and formulate questions;
  - ability to plan and with adequate methods to carry out advanced tasks and thereby contribute to the development of knowledge and ability to evaluate this work;
– ability to implement the above within specified time frame.

• **Criteria for very high goal fulfillment:** the documentation for evaluation indicates that student shows
  – significant ability to critically, independently and creatively identify and formulate questions;
  – significant ability to plan and carry out advanced tasks and thereby contribute to the development of knowledge and considerable capacity to evaluate this work;
  – significant capacity to implement the above within specified time frame.

**Objective 5:** For Master degree, student should demonstrate ability in both national and international contexts, orally and in writing to present and discuss their conclusions and the knowledge and arguments behind them, in dialogue with different groups.

• **Criteria for insufficient goal fulfillment:** the documentation for evaluation indicates that student shows
  – lack of ability in both national and international contexts, orally and clearly present and discuss own conclusions and the knowledge and arguments behind them, in dialogue with different groups;
  – lack of ability in both national and international contexts clearly in writing to present and discuss own conclusions and the knowledge and arguments underpinning these with different groups.

• **Criteria for high goal fulfillment:** the documentation for evaluation indicates that student shows
  – ability in both national and international contexts, orally and clearly present and discuss own conclusions and the knowledge and arguments behind them, in dialogue with different groups;
  – ability in both national and international contexts clearly in writing to present and discuss own conclusions and the knowledge and arguments underpinning these with different groups.

• **Criteria for very high goal fulfillment:** the documentation for evaluation indicates that student shows
  – significant ability in both national and international contexts, orally and clearly present and discuss own conclusions and the knowledge and arguments behind them, in dialogue with different groups;
  – significant ability in both national and international contexts clearly in writing to present and discuss own conclusions and the knowledge and arguments underpinning these with different groups.

**Objective 7:** For Master degree, student should demonstrate ability in the major field of study make judgments taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical issues in research and development.
• **Criteria for insufficient goal fulfillment**: the documentation for evaluation indicates that student shows
  – lack of ability to make judgments in the major field of study with respect to relevant scientific aspects;
  – lack of ability to make judgments in the major field of study with respect to relevant societal aspects;
  – lack of ability to make judgments in the major field of study with respect to relevant ethical issues;
  – lack of awareness of relevant ethical aspects of research and development.

• **Criteria for high goal fulfillment**: the documentation for evaluation indicates that student shows
  – ability to make judgments in the major field of study with respect to relevant scientific aspects;
  – ability to make judgments in the major field of study with respect to relevant societal aspects;
  – ability to make judgments in the major field of study with respect to relevant ethical issues;
  – awareness of relevant ethical aspects of research and development.

• **Criteria for very high goal fulfillment**: the documentation for evaluation indicates that student shows
  – significant ability to make judgments in the major field of study with respect to relevant scientific aspects;
  – significant ability to make judgments in the major field of study with respect to relevant societal aspects;
  – significant ability to make judgments in the major field of study with respect to relevant ethical issues;
  – significant awareness of relevant ethical aspects of research and development.
Chapter 2

How to satisfy requirements?

2.1 Bachelor degree

To satisfy the above requirements, your thesis may contain the following.

Table 2.1: A typical content of the bachelor thesis

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td><strong>Objective 1</strong></td>
<td>Survey of literature with comments related to the current research questions</td>
</tr>
<tr>
<td></td>
<td>Survey and comparison of alternative methods related to the subject of the project</td>
</tr>
<tr>
<td></td>
<td>Deeper presentation of specific methods supposed to be used in the project</td>
</tr>
<tr>
<td><strong>Objective 2</strong></td>
<td>Analysis of data, their quality, volume, shortage, etc (if any).</td>
</tr>
<tr>
<td></td>
<td>Description of the model and comparisons with alternative models</td>
</tr>
<tr>
<td><strong>Objective 3</strong></td>
<td>Formulation of the problem studied in the project and the goals of the project</td>
</tr>
<tr>
<td></td>
<td>Evaluation of possible solution in the time framework and presentation of solution (algorithms, results of experiments, description of programs, presentation of input-output interfaces, etc.</td>
</tr>
<tr>
<td></td>
<td>Program codes</td>
</tr>
<tr>
<td><strong>Objective 4</strong></td>
<td>Print of the oral presentation of the project</td>
</tr>
<tr>
<td></td>
<td>Improved English and the thesis structure (abstract, table of contents, sections, conclusion, references)</td>
</tr>
</tbody>
</table>

Continued at next page
The place of results in the area; the list of main results and achievements; potential use of results; possible future continuation of the project

**Objective 6**
Popular presentation of project and its results
Remarks concerned the use of Internet and correctness of citations
Ethically correct description of contribution of coauthors if any
Acknowledgement

**Summary of reflection of objectives in the Thesis** (where and how objectives are reflected in the thesis)

### 2.2 Master degree

To satisfy the above requirements, your thesis may contain the following.

**Table 2.2: A typical content of the master thesis**

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey of literature with comments related to the current research questions</td>
<td>Introduction</td>
</tr>
<tr>
<td>2. Survey and comparison of alternative methods related to the subject of the project</td>
<td>Theoretical sections</td>
</tr>
<tr>
<td><strong>Objective 2</strong></td>
<td>Theoretical sections</td>
</tr>
<tr>
<td>Deeper presentation of specific methods supposed to be used in the project</td>
<td>Theoretical sections</td>
</tr>
<tr>
<td><strong>Objective 3</strong></td>
<td>Theoretical sections</td>
</tr>
<tr>
<td>Analysis of phenomena, description of the model and comparisons with alternative models</td>
<td>Theoretical sections</td>
</tr>
<tr>
<td>Analysis of data, their quality, volume, shortage, etc.</td>
<td>Theoretical sections</td>
</tr>
<tr>
<td><strong>Objective 4</strong></td>
<td>Main sections</td>
</tr>
<tr>
<td>Formulation of the problem studied in the project and the goals of the project</td>
<td>Main sections</td>
</tr>
<tr>
<td>Evaluation of possible solution in the time framework and presentation of solution (algorithms, results of experiments, description of programs, presentation of input-output interfaces, etc.</td>
<td>Main sections</td>
</tr>
<tr>
<td>Program codes</td>
<td>Appendixes</td>
</tr>
<tr>
<td><strong>Objective 5</strong></td>
<td>Appendixes</td>
</tr>
<tr>
<td>Print of the oral presentation of the project</td>
<td>Everywhere</td>
</tr>
<tr>
<td>Improved English and the thesis structure (abstract, table of contents, sections, conclusion, references)</td>
<td>Everywhere</td>
</tr>
</tbody>
</table>

*Continued at next page*
2.3 Explanation to Tables 2.1 and 2.2

A thesis must be typed using some computer document preparation system. The thesis has to contain the following parts in the following order:

1. Title page.
2. Abstract.
3. Acknowledgements.
4. Table of contents.
5. Introduction.
6. One or more chapters or sections describing your research.
7. Conclusions.
8. List of references.

You may find templates for your title page at Blackboard. The abstract must be written at a separate unnumbered page. While writing abstract, imagine that you start to read your thesis and try to understand, what is it about. Your abstract has to show to the unprepared reader, why it can be interesting for him/her to read your work. Usually the abstract consists of not more than 5–6 sentences.

Never try to write your work in linear order, i.e., never start from the abstract! Usually you write the abstract when your work is completely ready.

Don’t forget to acknowledge people who helped you in preparation of your thesis.

Table of contents should start at a new page. This page must have number 2. As far as we know, Microsoft Word includes tools for automatic creation of contents. In \LaTeX , table of contents is creating by just one command:
Random fields appeared for the very first time in applied physical papers about turbulence. We would like to mention papers by Friedmann and Keller (1924), Kampé de Fériet (1939, 1954), Kampé de Fériet and Pai (1954a,b, 1955), von Kármán (1937a,b, 1948a,b), von Kármán and Howarth (1938), von Kármán and Lin (1951), Obukhov (1941a,b). An excellent introduction to probabilistic methods in turbulence may be found in Monin and Yaglom (2007a,b).

In the following paragraphs the author of [6] cites more books and papers and explains how they are related to the topic of his book.

Your introduction has to contain a popular presentation of project and its results. Here, you obtain a possibility to advertise your thesis. The following example is cited from the back cover of [6].

The author describes the current state of the art in the theory of invariant random fields. This theory is based on several different areas of mathematics, including probability theory, differential geometry, harmonic analysis, and special functions. The present volume unifies many results scattered throughout the mathematical, physical, and engineering literature, as well as it introduces new results from this area first proved by the author. The book also presents many practical applications, in particular in such highly interesting areas as approximation theory, cosmology and earthquake engineering. It is intended for researchers and specialists working in the fields of stochastic processes, statistics, functional analysis, astronomy, and engineering.

Do not forget to include remarks concerned the use of Internet, correctness of citations and self-control. For example:

Data used in my thesis have been downloaded from the Web page of Yahoo finance http://finance.yahoo.com. I did not copy material from any Internet Web page, but used the Internet preprint [1]. I certify that I have checked the correctness of all citations in this thesis.

Finally, if you are working together with a partner, you have to include an ethically correct description of contribution of coauthors. For example:

The first named author of the thesis has written and is responsible for Sections 1, 3, and 4. The second named author has written and is responsible for Sections 2, 5, and the text of the computer program in Appendix A. All the remaining parts of the thesis were written by the two authors together.
The first chapter or section after introduction has to contain the formulation of the problem studied in the project and the goals of the project. The problem has to be formulated in the same form as your supervisor formulated it for you. For example ([5]):

This paper is inspired by Geller and Marinucci (2008). After reading the above paper and several physical books and papers cited below, the author realized that cosmological applications require the theory of random fields in vector bundles. A variant of such a theory is developed in Section 2, while an application to cosmology is described in Section 3.

In the following paragraphs the author gives a short description of cosmological problems, explains why they require a new mathematical model, and describes his model and its applications.

At least one of chapters or sections in your thesis must be devoted to theoretical considerations. You have to describe the mathematical model that lies in the foundation of your thesis, to present a specific method of solution to the above described model, and to mention alternative solutions. For example:

The Scott’s stochastic volatility model [7] has the form

\[
\begin{align*}
    dS_t &= rS_t\,dt + \exp(Y_t)S_t(\rho\,dW_t + \sqrt{1-\rho^2}\,dB_t), \quad S_0 = s_0 > 0, \\
    dY_t &= \kappa(\theta - Y_t)\,dt + \nu\,dW_t, \quad Y_0 = y_0.
\end{align*}
\]

We would like to calculate the price on an European option in this model.

We describe solution step by step.

**Step 1** Make a logarithmic change of variables for the asset: \(X_t = \ln S_t\). We prove that the model becomes

\[
\begin{align*}
    dX_t &= (r - \exp(2Y_t)/2)\,dt + \exp(Y_t)(\rho\,dW_t + \sqrt{1-\rho^2}\,dB_t), \quad X_0 = \ln(s_0), \\
    dY_t &= \kappa(\theta - Y_t)\,dt + \nu\,dW_t, \quad Y_0 = y_0.
\end{align*}
\]

Indeed, . . .

You write proof of this fact, then go to step 2, and so on. When you finish to describe the algorithm, you present alternative solutions. For example:

Kahl and Jäckel [4] discuss various numerical integration methods for models with stochastic volatility and propose a simple numerical scheme. . . .

If you use real data in your thesis, do not forget to describe their quality, volume, etc. An example, taken from [2]:

In this section, we consider a series of intraday historical volatility/covolatility matrices for three stocks: ABX (Barrick Gold), BCE (Bell Canada Enterprise), NTL (Northern Telecom) traded on the Toronto Stock Exchange (TSX). The TSX
is an electronic market with continuous trading throughout the day that provides high frequency data on quotes and trades. For each stock, the 5 min interval returns are computed, and intraday realized historical volatility/covolatility matrices at frequency 5 min are built daily. There were 72 returns per day available for computing each matrix, as during the sampling period the market was opened between 9:30 a.m. and 4:30 p.m., and the first and last 30 min were deleted to remove the opening and closure effects. The sample covers one month (October 1998), and consists of data on 21 working days intraday volatility matrices. This series is sufficiently long for rolling estimation of the WAR, that might be of interest for financial practitioners. It is important to check if the WAR model provides a satisfactory fit to the data even when estimated on a sample from a short period of time. In fact, the number of observed variables is much greater than 21, as the observations on a series of symmetric matrices of dimension (3,3) result in \(21 \times 6 \times 126\) data points, since the cross-sectional dimension provides additional data... 

If the solution to the problem was not found by you, you have to present a computer realisation of the solution. Here you describe what programming language you chose and why, how you translated the algorithm from human language to programming language, which features of the chosen language helped you and eventually which features caused problems. Then you describe the input and output interface of your computer program. While doing this, imagine a person who is familiar with the problem and would like to solve it using your software. This person needs some kind of the *users guide* in order to understand the functions of all elements of the interface (buttons, text fields, etc) and to be able to obtain results and understand them. Optionally, you may include program codes to appendix.

Do not forget to include the results of your own experiments. Describe if your results coincide with the results of the authors of the proposed solution. You have to give an interpretation of your results in terms of the corresponding applied area (for example, economics, or finance).

In *conclusions*, you have to describe the list of your main results and achievements, their place in the area, how to use them, do you plan to continue this research in future. An example, taken from [1]:

Using the GMM we have investigated and compared popular volatility models (Models 1–6 in Table 2.1) with less well-known models (Models 7 and 8), in terms of their ability to explain the dynamics of the VIX. The analysis revealed that Models 7 and 8 outperformed Models 1—6, with all Models 1—6 found to impose overidentifying restrictions. The key to the good fit for Models 7 and 8 is their actual diffusion term which relates to the underlying with a power of \(3/2\). Interestingly, this was also the unconstrained estimate found by Chan et al. (1992) in their empirical work on short interest rates... 

Do not forget to include a special section which describes when and how the objectives give in Section 1.1 (for a bachelor thesis) or in Section 1.3 (for a master thesis) are reflected.
The list of references is an important part of your thesis. It consists of entries. Each entry contains required fields and optional fields. We describe examples of how to refer to the following entry types:

1. Article.
2. Book.
3. Bachelor or Master thesis.

For an article, the required fields are: author(s), title, journal, year, volume, and pages. Optional fields are: number and month. For example:


For a book, the required fields are: title, publisher, year, author(s) or editor(s). Optional fields are: volume, number in the series (if any), address of the publisher, and edition. For example:


For a Bachelor or Master thesis, the required fields are: author, title, school, type, and year. An optional field is month. For example:


For a PhD thesis, the required fields are: author, title, school, and year. An optional field is month. For example:


Note that our list does not contain Internet web pages. The reason is that a reference to sources which never have been under a peer review (like Wikipedia, etc) cannot be present in your thesis.

We recommend to use a computer program called JabRef, which may be found at the following address: [http://jabref.sourceforge.net/download.php](http://jabref.sourceforge.net/download.php). In this program, you create a database containing all the entries of your list of references. For each entry, you first chose its type from the list. The program automatically shows you the list of all required fields, which you have to fill. The database is readable by \LaTeX, your list of references will include only those entries that are cited in your thesis, and will be automatically formatted as required.

Remember, you can not copy more than one paragraph at the same time from other sources to your work, even if you give a reference to the source. This is considered as a plagiarism, and your work will be rejected.
Chapter 3

Miscellaneous questions

3.1 Tables

A table can look like this (taken from [6]):

<table>
<thead>
<tr>
<th>$X$</th>
<th>$G$</th>
<th>$K$</th>
<th>$\alpha$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S^n$</td>
<td>$\text{SO}(n + 1)$</td>
<td>$\text{SO}(n)$</td>
<td>$(n - 2)/2$</td>
<td>$(n - 2)/2$</td>
</tr>
<tr>
<td>$\mathbb{R}P^n$</td>
<td>$\text{SO}(n + 1)$</td>
<td>$\text{O}(n)$</td>
<td>$(n - 2)/2$</td>
<td>$-1/2$</td>
</tr>
<tr>
<td>$\mathbb{C}P^n$</td>
<td>$\text{SU}(n + 1)$</td>
<td>$\text{S(U(n) \times U(1))}$</td>
<td>$n - 1$</td>
<td>$0$</td>
</tr>
<tr>
<td>$\mathbb{H}P^n$</td>
<td>$\text{Sp}(n + 1)$</td>
<td>$\text{Sp}(n) \times \text{Sp}(1)$</td>
<td>$2n - 1$</td>
<td>$1$</td>
</tr>
<tr>
<td>$\mathbb{C}aP^2$</td>
<td>$\text{F}_{4(-52)}$</td>
<td>$\text{Spin}(9)$</td>
<td>$7$</td>
<td>$3$</td>
</tr>
</tbody>
</table>

Table 3.1: An example of a table.

Give a meaningful caption to your table. Don’t forget to explain the meaning of its contents. For example [6]:

In Table 3.1, $S^n$, $n \geq 1$ denotes the $n$-dimensional sphere, $\mathbb{R}P^n$, $\mathbb{C}P^n$, and $\mathbb{H}P^n$, $n \geq 2$ denote the $n$-dimensional projective spaces over real numbers $\mathbb{R}$, complex numbers $\mathbb{C}$ or quaternions $\mathbb{H}$ respectively, $\mathbb{C}aP^2$ denotes the projective plane over the octonions.

If your report or thesis contains tables, don’t forget to include list of tables. You can see the example of such a list at p. 3.

3.2 Figures

A figure can be included like here:
Figure 3.1: The main window of the applet `SimulationConvertible`. 

| Inputs for calculation |  |  |
|------------------------|------------------|
| Maturity               | 2.0              | Stock price     | 100.0 |
| Interest rate          | 0.05             | Volatility of stock | 0.4 |
| Face value             | 100.0            | Dividend yield  | 0.1  |
| Redemption value       | 1.0              | Call price      | 110.0 |
| Conversion ratio       | 1.0              | Call notice period | 15.0 |
| First call notice day  | 400.0            | No. of optimization paths | 4000.0 |
| Coupon payment         | 1.0E-4           | No. of simulation paths | 500.0 |
| Coupon period          | Quarterly        |  |  |

Results

<table>
<thead>
<tr>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
</tr>
<tr>
<td>Time</td>
</tr>
</tbody>
</table>

Optimization | 106,12 | Simulation | 105,97 | Average | 106,04 |
Give a meaningful caption to your figure. Don’t forget to explain its contents. For example [3]:

Figure 3.1 shows the main features of the exercise boundaries generated by the simulation model. For pricing the convertible bond the parameters are set as follows...

If your report or thesis contains figures, don’t forget to include list of figures. You can see the example of such a list at p. 4.

3.3 Formulas

All formulas can be divided into two categories:

- formulas inline within a paragraph;
- display formulas, typed at a separate line.

We will discuss only display formulas. A display formula can have a number, like this:

\[ e^{ix} = \cos x + i \sin x, \] (3.1)

or be unnumbered, like this:

\[ e^{ix} + 1 = 0. \]

Remember, you assign a number to a display formula if and only if there exists a reference to this formula in the text!

According to this rule, we must refer to our numbered formula somewhere in the text of this report. We are doing this now: formula (3.1) is known as the Euler’s formula.

\LaTeX{} simplifies managing tables and figures as well as creation of formulas. In particular, you can easily add a new numbered formula somewhere in the middle of your text. All the subsequent numbered formulas are renumbered automatically, and all references are updated. The same is true for tables and figures.

3.4 The last, but not the least

Before your presentation, don’t forget to double check the following items:

- Does your hardware (computer and projector) work properly?
- Does your software (MATLAB, Java, Power Point) work properly?
- Do you have two printed copies of your thesis in hands?
- Does the examiner have a copy of your thesis?
Bibliography


Appendix A

The Greek alphabet

\[
\begin{array}{llll}
A\alpha & \text{alpha} & B\beta & \text{beta} & \Gamma\gamma & \text{gamma} \\
\Delta\delta & \text{delta} & E\epsilon & \text{epsilon} & Z\zeta & \text{zeta} \\
N\eta & \text{eta} & \Theta\theta & \text{theta} & I\iota & \text{iota} \\
K\kappa & \text{kappa} & \Lambda\lambda & \text{lambda} & M\mu & \text{mu} \\
N\nu & \text{nu} & \Xi\xi & \text{xi} & O\omicron & \text{omicron} \\
\Pi\pi & \text{pi} & R\rho & \text{rho} & \Sigma\sigma & \text{sigma} \\
T\tau & \text{tau} & \Upsilon\upsilon & \text{upsilon} & \Phi\varphi & \text{phi} \\
X\chi & \text{chi} & \Psi\psi & \text{psi} & \Omega\omega & \text{omega} \\
\end{array}
\]
Appendix B

\LaTeX

There exist many different implementations of \LaTeX for different computer systems. Most of them are free.

In particular, one of the best free implementations for Microsoft Windows is called MIKTeX. This program can be downloaded from the Web site http://miktex.org. There, you can find detailed instructions concerning MIKTeX installation as well as a lot of useful references.

However, MIKTeX is a command-line program. To simplify your life, you need to install a dialogue shell for MIKTeX. A free program called TeXnicCenter is one of the best solutions and may be downloaded from http://www.texniccenter.org.

There exist a lot of free electronic books about \LaTeX in different languages. Most of them are included into MIKTeX distribution.
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