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# **An Example Master's Thesis**

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# ABSTRACT

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This is an example document of how to use the `csee_msc_thesis` document class.

The document class supports both Swedish and English theses, double or single sided print.



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# PREFACE

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The preface is the place where you can discuss some personal experiences with the project. This is also the place where you can thank people who helped you out.

Personally, I would like to thank all the test pilots who suggested changes, as well as reported bugs in the template. Keep it up, and I'll keep maintaining the template!

Johan Carlson



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# CONTENTS

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CHAPTER 1 – INTRODUCTION	1
1.1 General principles . . . . .	1
1.2 Revision history . . . . .	1
1.3 Making the document preamble . . . . .	3
1.4 Writing the rest of the report . . . . .	3
1.5 Including appendices . . . . .	4
1.6 Including bibliography references . . . . .	4
CHAPTER 2 – THE SECOND CHAPTER	5
2.1 Including graphics . . . . .	5
2.2 Special features . . . . .	5
APPENDIX A – LEAST SQUARES FIT OF RESPONSE SURFACE MODELS BY MULTIPLE LINEAR REGRESSION	7





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# CHAPTER 1

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## Introduction

This document serves both as an example of the L<sup>A</sup>T<sub>E</sub>X template for Master's theses, and at the same time as documentation on how to use it.

### 1.1 General principles

Use a main document to set up title page and chapters. In this way you can compile a subset of the entire thesis by simply commenting the `\input{...}` commands in the main document. Typeset the document by compiling the main document. The subdocuments can not be compiled by themselves.

The subdocuments should not contain any document style information. Just start writing the contents as in this file (`Chapter1/chapter1.tex`)

### 1.2 Revision history

The list below shows changes made to the template for each version and what (if any) changes you will need to do in your main document after upgrading the `.cls` file. The main document of this example will always be written for the current release of the template.

- Version 0.9: First version.
- Version 1.0, released November 17, 2004.
  - Various bug fixes (e.g. running headers, float-to-text spacing)
  - Changed typeface for body text to *Computer Modern*. Heading font still *Helvetica*.
  - Increased line spacing (5 %) for improved readability.

- New language option for the document class. You can now select Swedish (sv) or English (en). See main document for changes. Note that the `\makepreamble` command now requires an additional argument, containing a Swedish abstract. If you write the report in English, just leave this argument empty. For Swedish reports, the English abstract is still mandatory.
- Added support for onesided or twosided print. See main document for class declaration options.
- Version 1.01, released November 19, 2004.
  - Fixed bug in formatting of Bibliography list heading.
  - Added possibility to change the paragraph separation (and updated the .cls to manage this. See main document for more information.
  - Two more files (swedish.ldf and english.ldf) are now needed and should be placed in the same directory as the document. They contain updates for the “babel” package used to manage multiple languages.
- Version 1.02, released February 22, 2005.
  - Fixed a bug in the bibliography list (occurs if the list is more than one page). There is no change to the document class, but to the main document. See the main document of this example.
- Version 1.03, released March 17, 2005.
  - Fixed minor page numbering bug.
- Version 1.04, released March 17, 2005.
  - Fixed row spacing (paragraph breaking) class option (see this document for info).
  - Fixed language selection. Only class header declaration necessary now. Previous versions required a separate `\selectlanguage` command.
- Version 1.05, released March 24, 2005.
  - Fixed the `\cleardoublepage` command so that cleared pages are completely empty. Thanks David!
  - Fixed figure and table numbering issue in appendices.
  - Fixed a bug that caused page numbers to mysteriously disappear.
- Version 1.06, released November 20, 2008.

- Fixed a bug regarding `\belowcaptionskip` and the `listings` package. Thanks to the guys at the latex-community forum!
- Version 1.5, released June 7, 2009.
  - Various minor bug fixes (hardly anyone even noticed).
  - Name change! The template is now called `csee_msc_thesis`
- Version 1.6, released October 28, 2009.
  - Table of contents heading is now right-justified, just like all other chapter headings.
- Version 1.7, released November 27, 2009.
  - Fixed a bug in the numbering of tables.
  - Increased the number of section levels included in the table of contents.

## 1.3 Making the document preamble

The document preamble is a series of pages containing:

- A title page,
- an abstract (or two if you use the *Swedish* class option,
- and a preface page.

The title, author, address, abstract, preface are defined in the main document. To actually include it into the thesis, use the `\startpreamble` command provided by the document class. See the code of the main document for an example of how to use this. In this example, the abstract and preface are stored in separate files (containing only the actual text).

## 1.4 Writing the rest of the report

To add chapters, simply include one more in the main document. The chapter headings are automatically generated by the document template. See Chapter 2 on how to include graphics.

## 1.5 Including appendices

At the end of the thesis, after all chapters but before the reference list, you might want to add some appendices. To do this, simply type `\appendix` before the `\thebibliography` command and then add each appendix with the `\makeappendix` command (identical syntax as the `\makechapter` command). See Appendix A for a completely meaningless mathematical derivation.

## 1.6 Including bibliography references

At the end of the document you will have the list of bibliography references. In this thesis the BIBTEX reference system is used. Add your references to a database file and the reference list will be generated automatically. For more details on how to use the BIBTEX system, please refer to any good L<sup>A</sup>T<sub>E</sub>X documentation, e.g. [1] or [2].

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## CHAPTER 2

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# The second chapter

To add a second chapter, simply include it in the main document.

## 2.1 Including graphics

The template requires the `\graphicx` package for figure import. The package is included by the template by default.

To include graphics use, use the following code:

```
\begin{figure}[ht]
  \begin{center}
    \includegraphics[scale=1]{figures/ch2_fig1.pdf}
  \end{center}
  \caption{Example figure.\label{ch2:fig1}}
\end{figure}
```

This example will compile with `pdfLaTeX` and import the figure `ch2_fig1.pdf` stored in the **Figures** directory. If you wish to compile with `latex` instead of `pdflatex`, all pdf-figures have to be available as EPS (encapsulated PostScript) instead.

## 2.2 Special features

For some reason (currently unknown...) there has been a problem writing bold-face greek letters. A quick and dirty fix to the problem is included in the document class for some greek letters. See the `.cls` file for complete list.

Example: to define a bold  $\theta$ , the template defines the name `\bftheta`, which is declared

as `\def\bftheta{\mbox{\boldmath \theta}}`. This will be printed as  ***$\theta$*** .

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## APPENDIX A

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# Least squares fit of response surface models by multiple linear regression

If the number of experiments,  $n$ , exceed the number of model parameters,  $p$ , there will always be some aberrations between the model and the experimental data, i.e. there will be at least some residuals which are different from zero. Here is shown that the relation

$$(\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{y} = \mathbf{b} \quad (\text{A.1})$$

will always give the least squares estimate of the model parameters.

Let  $\mathbf{X}$  be the model matrix for a series of  $n$  experiments; let  $\mathbf{b}$  be the vector of model parameters to be estimated; let  $\mathbf{y}$  be the vector of measured responses, such that  $\mathbf{y}^T = [y_1, y_2, \dots, y_n]$ ; and let  $\mathbf{e}$  be the vector of unknown residuals,  $\mathbf{e}^T = [e_1, e_2, \dots, e_n]$ . For the series of experiments, the following relation applies

$$\mathbf{y} = \mathbf{X}\mathbf{b} + \mathbf{e}, \quad (\text{A.2})$$

i.e.

$$\mathbf{e} = \mathbf{y} - \mathbf{X}\mathbf{b}. \quad (\text{A.3})$$

$$\sum e_i^2 = \mathbf{e}^T \mathbf{e} \text{ (a scalar product)}. \quad (\text{A.4})$$

Develop the right part of (Eq. A.3) as a scalar product. This gives

$$\sum e_i^2 = (\mathbf{y} - \mathbf{X}\mathbf{b})^T (\mathbf{y} - \mathbf{X}\mathbf{b}) \quad (\text{A.5})$$

$$\sum e_i^2 = \mathbf{y}^T \mathbf{y} - 2\mathbf{y}^T \mathbf{X}\mathbf{b} + (\mathbf{X}\mathbf{b})^T \mathbf{X}\mathbf{b} \quad (\text{A.6})$$

$$\sum e_i^2 = \mathbf{y}^T \mathbf{y} - 2\mathbf{y}^T \mathbf{X}\mathbf{b} + \mathbf{b}^T \mathbf{X}^T \mathbf{X}\mathbf{b}. \quad (\text{A.7})$$

We wish to determine which set of model parameters minimizes the sum of squared residuals. This minimum can be found by solving the following systems of equations

$$\frac{\partial}{\partial \beta_j} \sum e_i^2 = 0, \text{ for all parameters } \beta_j. \quad (\text{A.8})$$

In matrix notation (see Appendix: Matrix calculus), the above expression can be written

$$\frac{\partial \mathbf{e}^T \mathbf{e}}{\partial \boldsymbol{\beta}} = \mathbf{0}, \quad (\text{A.9})$$

which corresponds to

$$\frac{\partial}{\partial \boldsymbol{\beta}} (\mathbf{y}^T \mathbf{y} - 2\mathbf{y}^T \mathbf{X} \boldsymbol{\beta} + \boldsymbol{\beta}^T \mathbf{X}^T \mathbf{X} \boldsymbol{\beta}) = \mathbf{0}. \quad (\text{A.10})$$

This gives

$$2(\mathbf{y}^T \mathbf{X})^T + [\mathbf{X}^T \mathbf{X} + (\mathbf{X}^T \mathbf{X})^T] \mathbf{b} = \mathbf{0}. \quad (\text{A.11})$$

The matrix  $\mathbf{X}^T \mathbf{X}$  is symmetric and  $\mathbf{X}^T \mathbf{X} = (\mathbf{X}^T \mathbf{X})^T$  and the above expression is equivalent to

$$\mathbf{X}^T \mathbf{y} = \mathbf{X}^T \mathbf{X} \mathbf{b}. \quad (\text{A.12})$$

Provided that  $(\mathbf{X}^T \mathbf{X})^{-1}$  exists, a multiplication of both sides by  $(\mathbf{X}^T \mathbf{X})^{-1}$  affords the least squares relation

$$(\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{y} = \mathbf{b}. \quad (\text{A.13})$$

Q.E.D.



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## REFERENCES

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- [1] L. Lamport, *LaTeX, A Document Preparation System: User's Guide And Reference Manual*. New York: Pearson Professional Education, 1994.
- [2] M. Goossens, F. Mittelbach, and A. Samarin, *The LaTeX Companion*. Addison-Wesley, 1994.