For submission to The PracTEX Journal
Draft of December 2, 2008

Writing a thesis with LaTeX

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Abstract This article provides useful tools to write a thesis with LaTeX. It analyzes the typical problems that arise while writing a thesis with LaTeX and suggests improved solutions by handling easy packages. Many suggestions can be applied to book and article styles, as well.

*I would like to thank Fabiano Busdraghi who helped me to write sec. 4, Massimiliano Dominici who took care of the Linux and UNIX systems in sec. 4.1.2 and Riccardo Campana who took care of the Macintosh system in sec. 6.2.2. I would also like to thank everyone else who contributed and in particular Valeria Angeli, Claudio Beccari, Barbara Beeton, Gustavo Cevolani, Massimo Guiggiani, Maurizio Himmelmann, Caterina Mori, Søren O'Neill, Lorenzo Pantieri, Francisco Reinaldo, Yuri Robbers, and Emiliano Vavassori. Without their help this article wouldn't have reached the current form.

Contents

Preface

This article is not a guide on how to write a thesis but explains how to rightly use LaTeX resources when writing it. I will not cover all variant details because there are many, so I prefer to focus on specific problems and offer practical solutions. In order to follow this article, the reader should already know the basics of LaTeX and should already have read a guide [1, 2, 7, 12, 21, 25, 27] or a book [4, 8, 10, 11, 13, 14, 16–18].

1 The document class

The book class is the most suitable to write a thesis. The author has freedom to choose the following class options:

- font size (`10pt`),[1]
- paper size (typically `a4paper` or `letterpaper`),
- if having the text on both sides of the page (`twoside`) or only on the front (`oneside`),
- if placing the chapter titles only on right pages (`openright`) or any (`openany`).

The book class has some advantages over the report class since it defines three commands (`\frontmatter`, `\mainmatter`, and `\backmatter`)[2] that control the page number and chapter numbering formats. In the *frontmatter*, pages are numbered with lower case Roman numbers (i, ii, iii, etc.) and the chapters are not numbered (as if the asterisk version `\chapter*{}` was used). In the *mainmatter*, pages are numbered with Arabic numbers (the numbers start from 1) and the chapters are numbered with Arabic numbers as well. In the *backmatter*, the pages are numbered as in the mainmatter (numbering continues) but the chapters are not numbered.

The `twoside` option is recommended because:

- it halves the waste of paper,[3]
- it allows for different headers for left and right pages,

1. For good readability on A4 and letter paper it is advisable to use a base font size of 11 pt.
2. Information on how to use these commands is reported in sec. 3.
3. Unfortunately most students try to use every typographic trick to increase the number of pages of their thesis (widening the margins, increasing the font size, increasing the line spacing, adding a lot of figures, printing on one side only, etc.). Beside the fact that the quality of the content is far more important than the quantity, these tricks usually produce an ugly layout. The advice is to focus on the content and leave the typographic job to LaTeX (which is, by the way, pretty good at it).

– it produces the same layout as most books.

For example, the following command formats the thesis on both faces of letter paper, with an 11 pt base font size, with chapter titles always on the right hand page:

```
\documentclass[11pt,letterpaper,twoside,openright]{book}
```

The memoir class is a good alternative since it is very flexible and customizable (headers and footers, chapter titles, footnotes, table of contents, other lists, etc.).

2 Organizing the files

Managing a complex document, such as a book or a thesis, can be complicated and so it is advisable to divide it into several files. LaTeX lets you work with several files, but a main file should control them with `\include` or `\input` commands. On the one hand, the `\input{filename}` command can be used to call a file. It can even be nested so that an `\inputed` file can `\input` files of its own. On the other hand, the `\include{filename}` command defines the command `\includeonly` with features to compile just some of the files that are called throughout the document, `\includeonly{filename1,filename2,...}`. When using `\includeonly{filename1,filename2,...}`, LaTeX compiles just the files that are between the curly braces and does not update the counters (i.e. page numbers, footnote numbers, etc.) making the process faster.

3 Sections of the thesis

The structure of a thesis is broadly discussed in specific books and especially by specific ISO rules that discuss the presentation of technical reports [15]. This section proposes a possible structure and analyzes the problems that arise for each section.

A thesis can have the following structure:[4]

- Title page°
- Dedication*°
- Abstract*°
- Acknowledgements*°
- Table of contents and other lists°
- Table of symbols and notation*
- Preface*

} frontmatter

- Inner chapters
- Appendices*

} mainmatter

- Bibliography
- List of acronyms*
- Index*

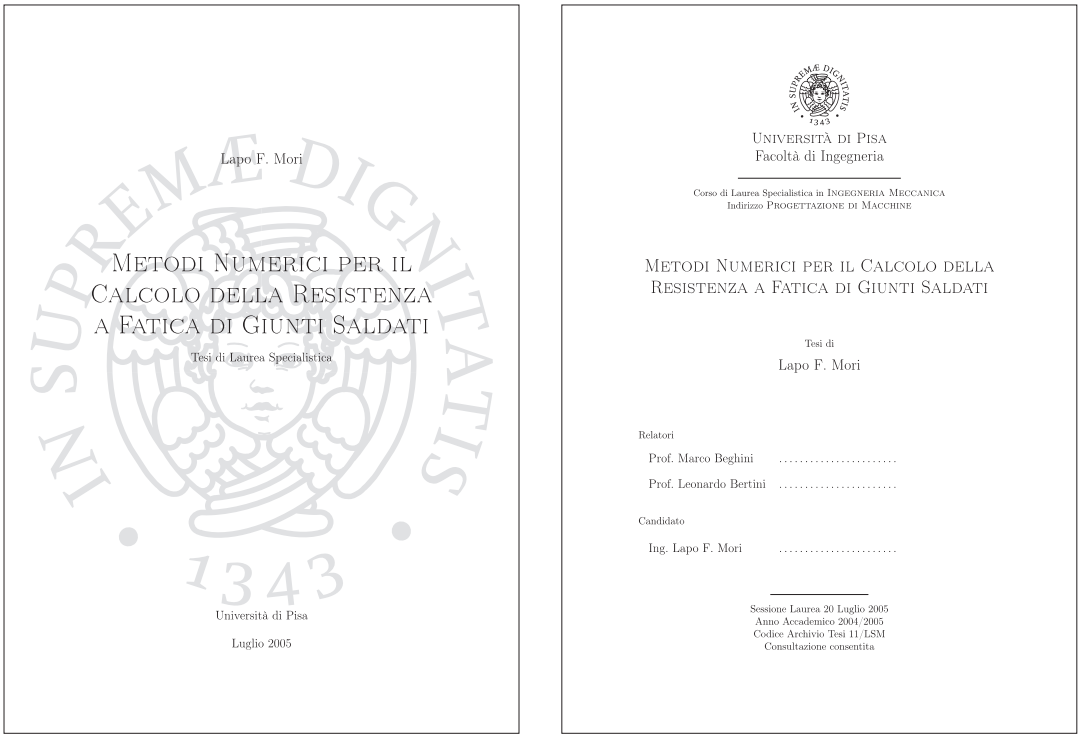
} backmatter

3.1 Title page

Since the thesis layout and contents are usually defined by university requirements, the title page often needs to be created *ad hoc*. The title page is often formed by two pages; the first one reports just the name of the candidate and the second one also that of the advisors, the department chair and their signatures. The standard LaTeX commands [4, 7, 8, 10, 16–18, 21] should be sufficient to create these pages. Some hints on how to set the code are available on the Web.[5]

4. The symbol * indicates optional sections and ° indicates sections that should not be in the table of contents.

5. http://zoonek.free.fr/LaTeX/LaTeX_samples_title/0.html



(a) **(b)**

Figure 1: Example of title page.

In order to place the university coat of arms in the page background as in Fig. 1a, the eso-pic package and the following command can be added to the preamble

```
\newcommand\AlCentroPagina[1]{%
    \AddToShipoutPicture*{\AtPageCenter{%
    \makebox(0,0){\includegraphics%
    [width=0.9\paperwidth]{#1}}}}}
```

and then use it as

```
\AlCentroPagina{seal_name}
```

The dots on which to place the signature (Fig. 1b) can be obtained with the `\dotfill` command. The titling package allows one to modify the behavior of

the `\maketitle` command. However, the thesis title page is usually so different from that produced by the standard LaTeX classes that it is easier to redefine it from scratch.

3.2 Dedication

The dedication, when present, can have many different formats depending on the author's taste. Usually (Fig. 2) it is just a line aligned to the right which can be obtained with

```
\begin{flushright}
...
\end{flushright}
```

The vertical position of the dedication can be arbitrary. An easy way to control it is with a couple of `\vspace{\stretch{...}}` commands which let the user decide the ratio between the space preceding and the one following the line. For example, in order to set the space following the dedication twice as wide as that preceding, it is possible to use the command

```
\null\vspace{\stretch{1}}
...
\vspace{\stretch{2}}\null
```

3.3 Abstract

The abstract is generated by the environment

```
\begin{abstract}
...
\end{abstract}
```

which is available for the article and report classes. When using the book class it is necessary to define the abstract in the preamble (the code that follows is the definition used by the report class).[6]

6. Instructions on how to use the fancyhdr package can be found in sec. 6.3.1.

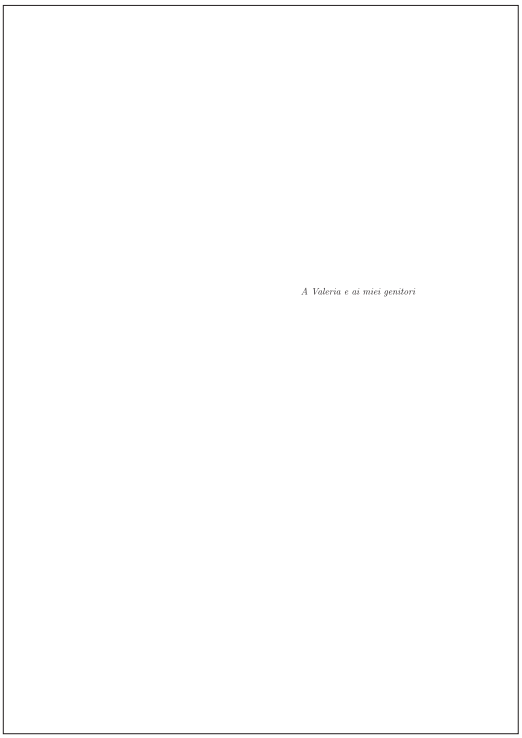


Figure 2: Example of dedication.

```
\usepackage{fancyhdr}
\pagestyle{empty}



\newenvironment{abstract}%
{\cleardoublepage\null \vfill\begin{center}%
\bfseries \abstractname \end{center}}%
    {\vfill\null}
```

Sometimes it is useful to have the abstract written in two languages. The babel package can be used to select the correct name of the abstract and the hyphenation. If, for example, you need to write the abstract both in Italian and in English, you need to load the babel in the preamble with

```
\usepackage[english,italian]{babel}
```

and then use the following commands in the text:

```
\selectlanguage{italian}%
\begin{abstract}
... versione del sommario in italiano ...
\end{abstract}


\selectlanguage{english}%
\begin{abstract}
... English version of the abstract ...
\end{abstract}
\selectlanguage{italian}%
```

The result is reported in Fig. 3.

3.4 Table of contents and other lists

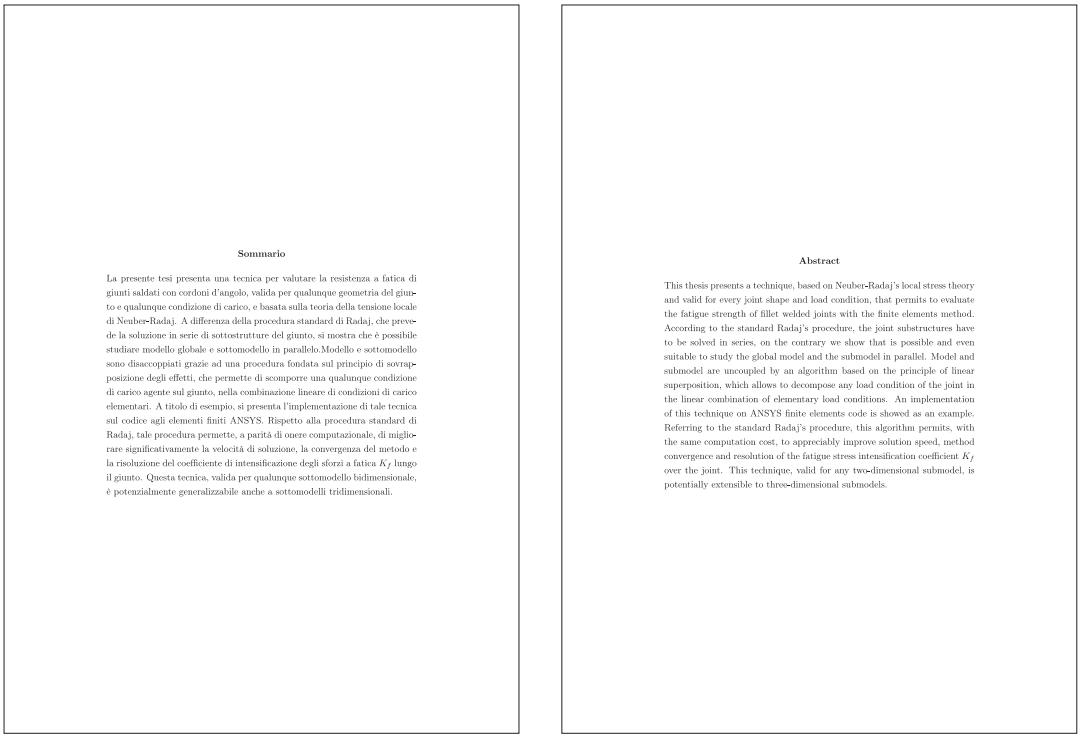
The table of contents and the other lists usually come right after the abstract in the following order:

- table of contents
- list of figures
- list of tables
- other lists

These are automatically created with LaTeX using the commands:

```
\tableofcontents
\listoffigures
\listoftables
```

The float package, with the `\newfloat` and `\listof` commands, can be used to create lists of custom floating objects (e.g. programs, algorithms, etc.). The tocloft package can be used to modify their layout.



Sommario

La presente tesi presenta una tecnica per valutare la resistenza a fatica di giunti saldati con cordoni d'angolo, valida per qualunque geometria del giunto e qualunque condizione di carico, e basata sulla teoria della tensione locale di Neuber-Radaj. A differenza della procedura standard di Radaj, che prevede la soluzione in serie di sottostrutture del giunto, si mostra che è possibile studiare modello globale e sottomodello in parallelo.Modello e sottomodello sono disaccoppiati grazie ad una procedura fondata sul principio di sovrapposizione degli effetti, che permette di scomporre una qualunque condizione di carico agente sul giunto, nella combinazione lineare di condizioni di carico elementari. A titolo di esempio, si presenta l'implementazione di tale tecnica sul codice agli elementi finiti ANSYS. Rispetto alla procedura standard di Radaj, tale procedura permette, a parità di onere computazionale, di migliorare significativamente la velocità di soluzione, la convergenza del metodo e la risoluzione del coefficiente di intensificazione degli sforzi a fatica K_f lungo il giunto. Questa tecnica, valida per qualunque sottomodello bidimensionale, è potenzialmente generalizzabile anche a sottomodelli tridimensionali.

(a)

Abstract

This thesis presents a technique, based on Neuber-Radaj's local stress theory and valid for every joint shape and load condition, that permits to evaluate the fatigue strength of fillet welded joints with the finite elements method. According to the standard Radaj's procedure, the joint substructures have to be solved in series, on the contrary we show that is possible and even suitable to study the global model and the submodel in parallel. Model and submodel are uncoupled by an algorithm based on the principle of linear superposition, which allows to decompose any load condition of the joint in the linear combination of elementary load conditions. An implementation of this technique on ANSYS finite elements code is showed as an example. Referring to the standard Radaj's procedure, this algorithm permits, with the same computation cost, to appreciably improve solution speed, method convergence and resolution of the fatigue stress intensification coefficient K_f over the joint. This technique, valid for any two-dimensional submodel, is potentially extensible to three-dimensional submodels.

(b)

Figure 3: Example of abstract in two languages.

3.5 Table of symbols and notation

It is sometimes useful to give the reader a table with the symbols and the notation used in the thesis (Fig. 4). The nomencl package automatically generates such a list with the MakeIndex program. It is otherwise possible to manually create the table with the tabular environment.

3.6 Appendices

The appendices are normal chapters whose numbering is with the Roman alphabet letters. They can be created just by using the `\chapter{...}` command

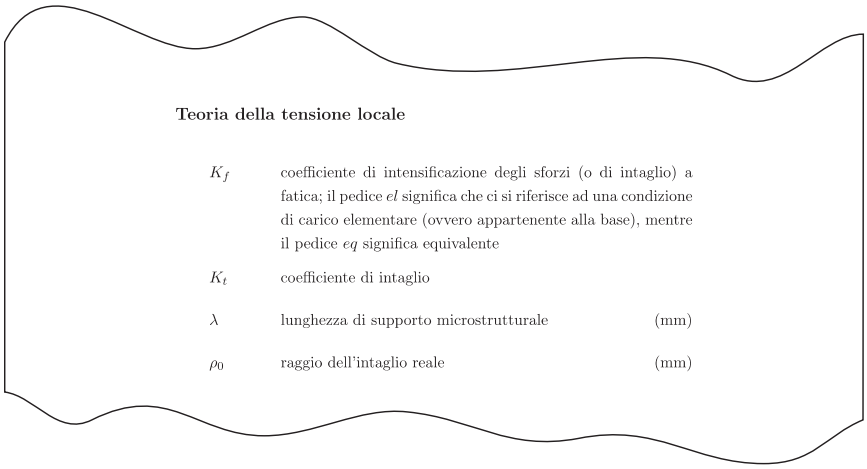


Figure 4: Example of a list of symbols.

preceded by `\appendix`[7] as in the following example:

```
...
\mainmatter
\include{chapter1}
\include{chapter2}
\include{chapter3}


\appendix
\include{appendix1}
\include{appendix2}
...
```

3.7 Index

The index can be automatically created with the makeidx package and the MakeIndex program. The `\makeindex` command must be in the preamble. In order to balance the columns of the last page of the index, it can be inserted into a `multicols`

7. `\appendix` must be used only once even if there are multiple appendices.

environment[8] redefining the `theindex` environment with the following code

```
\let\orgtheindex\theindex
\let\orgendtheindex\endtheindex
\def\theindex{%
  \def\twocolumn{\begin{multicols}{2}}%
  \def\onecolumn{}%
  \clearpage
  \orgtheindex
}
\def\endtheindex{%
  \end{multicols}%
  \orgendtheindex
}
```

3.8 Bibliography

The bibliography, like the index, can be automatically generated by LaTeX. It can be created with the thebibliography environment, but it is far better to use BibTeX, a program that lets you separate the content of the bibliography (stored in `.bib` databases) and the style (defined by `.bst` files). The `.bib` files are just text files that can be created with any text editor but it is advisable to use bibliography dedicated editors. JabRef[9] is one of the best bibliography managers and, being based on Java VM, it is available for all platforms (Windows, Linux, and Mac OS X).

The natbib package is a very useful and flexible tool to format both the bibliography and the references in text and it is thoroughly described in its guide. Every LaTeX distribution and the natbib package offer several bibliography styles; it is, however, possible to create a custom style. The user just needs to compile the `makebst.tex` file and interactively answer the questions. This process creates a `.dbj` file that just needs to be compiled with LaTeX to produce the `.bst` style. The

8. This environment requires the multicol package.
9. http://jabref.sourceforge.net/

`\url{}` command provided by the `url` package automatically breaks long URLs over several lines. The bibliography can be added to the table of contents with the `\addcontentsline` command.

The following code typesets the references with the plain style, adds the bibliography to the table of contents (for a thesis the bibliography section is a chapter), and loads the `ThesisBib.bib` database. The name of the bibliography section is added to table of contents with the `\bibname` command in order to let it be dependent on the language used.[10]

```
\cleardoublepage
\bibliographystyle{plain}
\refstepcounter{chapter}
\addcontentsline{toc}{chapter}{\bibname}
\bibliography{ThesisBib}
```

4 Objects

4.1 Figures

Figures are one of the most popular subject for LaTeX guides. There are even guides and books [3, 9, 23] completely dedicated to this subject. The reader should refer to them for the details.

LaTeX users are usually faced with two kinds of problems regarding the figures. The first kind has its origin in the figure file itself and will be discussed in sec. 4.1.1, the second kind regards their placement and will be discussed in sec. 4.3.

10. `\bibname` becomes "Bibliography" with the `english` option, "Bibliografia" with the `italian` option.

4.1.1 Formats

Images can be divided into two big classes: vector images and bitmap images. The format to use should not be chosen arbitrarily since each one is suitable for different purposes. The first class, defined as groups of geometric shapes, can be scaled and deformed without losing definition or sharpness and is recommended for graphs, schemes and every other image that can be defined in terms of simple geometric entities. The second class, defined as matrices of colored pixels, cannot be deformed without altering the information content and should be used only in cases in which vector graphics are not usable, i.e. for photographs, artistic paintings, etc.

The conversion between vector and bitmap graphics should always be avoided. In fact, on the one hand the conversion from vector (e.g. `.eps` or `.pdf`) to bitmap image (e.g. `.bmp`, `.jpg` or `.png`) eliminates all the information on the geometry contained in the figure and deteriorates the quality of the image and the possibility to resize it without losing any detail. On the other hand, the conversion from a bitmap to vector graphics does not improve its quality, it just inserts the bitmap inside a vector frame. The only way to obtain a true vector graphic image from a bitmap is to trace it with dedicated applications such as Potrace.[11]

The bounding box is a fundamental parameter of `.eps` files. It defines the size of the image and is used by LaTeX to compute how much space to assign to the figure. The bounding box should ideally be the minimum rectangle that contains the image. Sometimes, however, graphics applications leave margins (i.e. empty space) between the image and its bounding box. This may cause some confusion because, although LaTeX assigns the correct space to the figure, it may seem that the figure is too small, not centered, etc. Ghostview[12] can be used to open the figure, visualize the bounding box, and check if the dimensions are correct. If they are not, the best option is to change settings in the application that

11. http://potrace.sourceforge.net/

12. http://www.ctan.org/tex-archive/help/Catalogue/entries/ghostscript-afpl.html

generated the `.eps`. Alternatively GSView[13] can compute the optimal bounding box[14] or the user can directly open the `.eps` file with a text editor and modify the values defining the bounding box, which are usually in the first few lines. The details on how to use figures with PDFLaTeX and to convert them from `.eps` to `.pdf` are reported in sec. 5.2.

4.1.2 Useful packages

The graphicx package needs to be loaded in order to insert figures. Its guide is very useful.[15] Subfigures (Fig. 1) can be obtained with the subfig package.[16] In many cases this package is not even needed since more than one figure or table can be inserted into a figure or table environment, as shown in the following example

```
\begin{figure}[tb]
  \includegraphics[width=0.3\textwidth]{fig:a}
  \caption{caption:a}\label{fig:a}
  \hspace{4em}
  \includegraphics[width=0.3\textwidth]{fig:b}
  \caption{caption:b}\label{fig:b}
\end{figure}
```

This is a good way to reduce the number of floating objects and to facilitate their placement.

It is advisable to collect all the figures in one or more subfolders to keep the source files in order. If the `fig:a` figure is inside the `fol_1` folder, the user should specify it

```
\includegraphics{fol_1/fig:a}
```

By the way, it is far more convenient to specify the folder's name just once in the preamble with the command

13. http://www.ctan.org/tex-archive/help/Catalogue/entries/gsview.html
14. File - PS to EPS - Automatically calculate Bounding Box.
15. http://tug.ctan.org/tex-archive/macros/latex/required/graphics/grfguide.pdf
16. This package supersedes the subfigure package, which has been declared obsolete by its own author.

```
\graphicspath{{fol_1/},{fol_2/}}
```

The path declared with `\graphicspath` can be relative to the folder hosting the main `.tex` file (as in the previous example), or absolute,[17] as, for example,

```
\graphicspath{{c:/documents/thesis/images/}}
```

The caption package lets you format captions easily.

4.2 Tables

The ctable package improves the spacing of the standard tabular environment. The xcolor package with the table option can be used to color the background or rows, columns, and cells. When dealing with big tables, it is possible to:

- scale down the table, for example with the following commands:

```
\begin{center}
    \resizebox{0.95\textwidth}{!}{%
    \begin{tabular}
    ...
    \end{tabular}}
\end{center}
```

- rotate the table by 90° with the rotating package,[18]
- break the table over several pages with the supertabular package.

For further details the reader can refer to a specific guide, such as [20].

4.3 Controlling the floating objects

LaTeX users often complain about the position of figures (and of floating objects in general). In most cases, this is caused by using the position options for the

17. On Linux or UNIX systems the absolute path cannot take advantage of the tilde expansion. For example `\graphicspath{{/home/lapo/documents/thesis/images/}}` should be used instead of `\graphicspath{{~/documents/thesis/images/}}`.

18. Other techniques to rotate tables and figures are reported in [28].

floating objects incorrectly. This section explains what should be done while writing (sec. 4.3.1) and what while reviewing the text (sec. 4.3.2).

4.3.1 What to do while writing

First of all the user should accept the fact that LaTeX moves a floating object either because there is no space on a given page or for esthetic reasons. Luckily, when using the right commands, LaTeX does a very good job.

The very first thing to do is to avoid commands like `\clearpage` and let LaTeX automatically choose the position of the floating objects: while writing the thesis, the author should be focused only on the content and not be concerned with the layout. Almost any interference in the complex routine that LaTeX uses to place the floats, will cause poorer results. The following suggestions ensure that the floats are placed as close as possible to their insertion point without any intervention by the author.

One of the major causes of problems is the use of the `[h]` option which tells LaTeX to place the figure at the same point where it appears in the code. Even worse than `[h]` are the `[htbp]` and the `[h!t]` options. It is a common misbelief that this option is the best to guarantee that the object remains close to the point where it appears in the code. It actually works only when the object is very small (compared to `\textheight`). The only thing that the author should determine is whether the object is small enough to appear on a page with other text or will require a whole page to itself. In the first case the best option is `[tb]`, in the second `[p]`. If there are no floats left to place, then in the first case LaTeX will place the object just before its insertion point (which cannot happen when using `[h]`) or on the following page. When using the `[p]` option for big objects, they will be placed on a separate page right after the insertion point and not at the end of the chapter as in the case of `[tbp]`. This is what is done in every book with a good layout: the figures are either at the top or at the bottom of a page, on a blank page if very big, and in the text if very small. Some users are annoyed with figures that precede their reference in the text (e.g. a figure that appears at

the top of the page of its reference in the text). This problem can be easily solved with the flafter package that prevents the floating object from appearing before its definition in the text.

In general, LaTeX chooses a good place for figures if the ratio

$$\frac{\text{text}}{\text{figures}}$$

is sufficiently high. Thus it is advisable, also from a typographic point of view, to write something interesting instead of filling up the thesis with figures. If this ratio is too low, LaTeX may produce this error:

```
! LaTeX Error: Too many unprocessed floats.
```

This is due to the fact that LaTeX can allocate only a limited amount of memory to place the floating objects. If there are too many floats to be processed, this amount of memory might be insufficient [5]. This problem can be solved with the `\FloatBarrier` command, provided by the placeins package, which cannot be crossed by floating objects and forces LaTeX to place all the ones that are still in memory. If possible, even the `\clearpage` command can be used. It inserts a page break and also places all the unprocessed floats. The morefloats package increases the number of floats that can be held in memory from 18 to 36. Some journals require that all the figures are placed at the end of the draft. The endfloat package does that automatically.

Should all these tricks not be enough, the user can make some manual adjustments just before printing, as explained in the next section.

4.3.2 What to do while reviewing

Just before printing the thesis, it might be necessary to manually adjust the position of some floating objects such as tables and figures. The float package provides the `H` position option which make the floating objects non-floating and forces their placement in the exact place in the text. The `\FloatBarrier` command (see sec. 4.3.1) can even be used to fine tune the position of some objects.

LaTeX provides some commands to globally control the floating objects:

`\setcounter{topnumber}{...}` maximum number of floats in `t` position for each page

`\def\topfraction{...}` maximum page fraction for floats in `t` position for each page

`\setcounter{bottomnumber}{...}` maximum number of floats in `b` position for each page

`\def\bottomfraction{...}` maximum page fraction for floats in `b` position for each page

`\setcounter{totalnumber}{...}` maximum number of floats in the same page

`\setcounter{dbltopnumber}{...}` maximum number of big floats in the same page

`\def\textfraction{...}` minimum fraction of the page for the text

`\def\floatpagefraction{...}` minimum page fraction for floats in `p` position for each page

`\def\dbltopfraction{...}` maximum part of a two-column text page that can be occupied by two-column floats at the top.

`\def\dblfloatpagefraction{...}` minimum part of a page that has to be occupied by two column wide floating objects before a 'float page' is produced.

5 Compiling the code

5.1 Choosing the format

The LaTeX code can be compiled to obtain a DeVice-Independent file (`.dvi`) or a Portable Document Format file (`.pdf`).[19] Each format has advantages and disad-

19. There is actually a third option, the PostScript file (`.ps`), but it has been substituted by the `.pdf` format as the *de facto* standard.

vantages. On the one hand, the `.dvi` allows a direct search (with a double click on the code inside the text editor, the `.dvi` viewer finds the corresponding output) and inverse search (with a double click on the output inside the `.dvi` viewer, the text editor positions the cursor at the corresponding position in the code) that are very useful when writing the thesis. Unfortunately most `.dvi` viewers do not render the effects of the graphicx package properly – such as `\resizebox` and `\rotatebox`[20] and cannot take advantage of the microtype package (see sec. 5.2). The `.pdf` format, on the other hand, although it does not allow direct and inverse search,[21] correctly renders all the effects of the graphicx package, takes advantage of the microtype package, is a very popular format even outside the TEX and LATEX community, takes advantage of the hypertext links of the hyperref package, and allows to restrict the document access with a password.[22]

In conclusion, it is recommended to use the `.dvi` while writing and the `.pdf` for printing the thesis and distributing it in electronic format.

5.2 Creating a PDF

There are several ways to create a `.pdf` with LATEX, such as:

- converting a `.dvi` or a `.ps` file with Ghostscript,
- directly compiling the source `.tex` code with PDFLATEX.

Without going into the details, for which a good reference is [24], in order to exploit all the potential of the PDF format[23] it is necessary to use PDFLATEX which is available in most LATEX distributions.

20. YAP (MiKTEX `.dvi` viewer) solved this problems since the 2.5 version.
21. The MacTeX distribution for Apple computers allows direct and inverse search even with `.pdf` files.
22. A password can be used to limit access to the document, to limit the print options (restrict it or allow it only at low resolution), and to limit changes (text extraction, page extraction or removal, etc.).
23. The PDF format allows to use hypertext, bookmarks, thumbnails, and document information which are not available when converting `.dvi` and `.ps` files.

The main difference between the two methods is the file format for the figures; while the compilation to `.dvi` or `.ps` files requires `.eps` images, PDFLaTeX requires `.pdf` (if vector graphics) or `.jpg` and `.png` (if bitmap).[24] In order to use PDFLaTeX, the user is required to convert all `.eps` into `.pdf` files. The conversion can be easily done with Ghostscript by using the graphical user interface eps2pdf.[25] If the document has to be compiled both with LaTeX and PDFLaTeX it is advisable not to specify the extension of the image files in the `\includegraphics` command; if, for example, the document has the `figure_01.eps` image, the user need to convert it into `figure_01.pdf` with eps2pdf and then add to the code

```
\includegraphics{figure_01}
```

In this way, LaTeX automatically loads `figure_01.eps` and PDFLaTeX `figure_01.pdf`.

The hyperref package needs to be loaded in order to create hypertext links in a document.[26] To learn how to use TrueType fonts with TeX (LaTeX) and PDFTeX (PDFLaTeX) the reader can visit http://www.radamir.com/tex/ttf-tex.htm. The microtype package is highly recommended when using PDFLaTeX because it improves line filling with:

- *font expansion*: it horizontally expands the characters in order to optimally fill each line;
- *character protrusion*: it lets some characters protrude into the margins (typically the hyphens and punctuation signs).

These two modes are already enabled when the package is loaded without any options:

```
\usepackage{microtype}
```

24. The details about image format are reported in sec. 4.1.1.

25. eps2pdf is a graphical user interface for Windows and is available on CTAN (http://www.ctan.org/tex-archive/support/eps2pdf/). Linux users can use the homonymous `sh` procedure or epstopdf (both of them from command prompt). All these programs just use GhostScript to convert `.eps` into `.pdf`.

26. Even some `.dvi` viewers support hypertext links.

6 Useful packages

6.1 Hyphenation

Hyphenation is controlled by the babel package and depends on the active language. If the thesis is in English, the following command should be used

```
\usepackage[english]{babel}
```

The babel package is required for hyphenation but not sufficient: the file with the hyphenation patterns for the used language should be active (refer to the documentation of the LaTeX distribution used).[27] For English the definition file is `hyphen.tex`.

LaTeX correctly syllabifies almost every English word. However, in some cases, when using rare words or names, the author might need to suggest the correct hyphenation with the command `\hyphenation` in the preamble. The words must be between curly braces and separated by a space as in the following example

```
\hyphenation{hy-phen-a-tion mar-vel-ous-ly}
```

This command can even be used to prevent some words from being syllabified: they just need to be written without hyphens as in the following example:

```
\hyphenation{MATLAB Mathematica}
```

When a word appears just once or only a few times, it is possible to suggest the hyphenation directly in the text with the `\-` command as in the following example

```
hy\-phen\-a\-tion
```

The author should always remember that all manual operations on the hyphenation should be done only during the review process immediately before printing. It is often better to rewrite a sentence that causes an `overfull` warning than to impose a certain hyphenation.

27. Here is reported as an example the procedure to activate the `hyphen.tex` file on MiKTeX: from the "languages" panel on "MiKTeX options" activate "english – hyphen.tex" and then update the formats with "Update Formats" in "General".

6.2 Languages other than English

6.2.1 Indentation

In some languages (e.g. Italian) the first paragraph needs an indentation on the first line (Fig. 5). This can be easily achieved with the indentfirst package.

6.2.2 Accented letters

Accented letters can be inserted into LaTeX code with the standard commands[28] (`\‘{e}`, `\’{e}`, etc.) or directly from the keyboard (è, é, etc.) using the inputenc package with the appropriate encoding. The inputenc options depend on the editor that is used. `[ansinew]` has to be used with most editors on Windows (e.g. WinEdt and TeXnik Center); `[latin1]` or `[latin9]` with most editors on Linux, UNIX, and Mac OS X; `[applemac]` with Macintosh computer using an operating system prior to OS X and even OS X depending on the encoding used by the editor;[29] `[utf8x]` can be used only on some editors such as on Linux and TeXShop on Mac OS X.

6.3 The layout

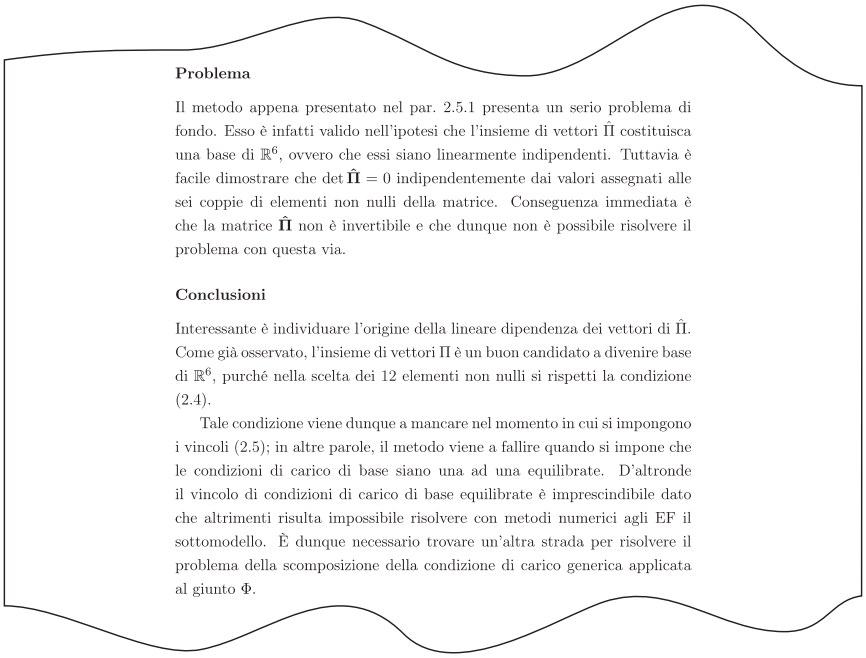
6.3.1 Headers and footers

The fancyhdr package is very useful to customize headers and footers. In a thesis, headers and footers usually differ from one part to the other. It is convenient to define commands that change their behavior as in the following example:

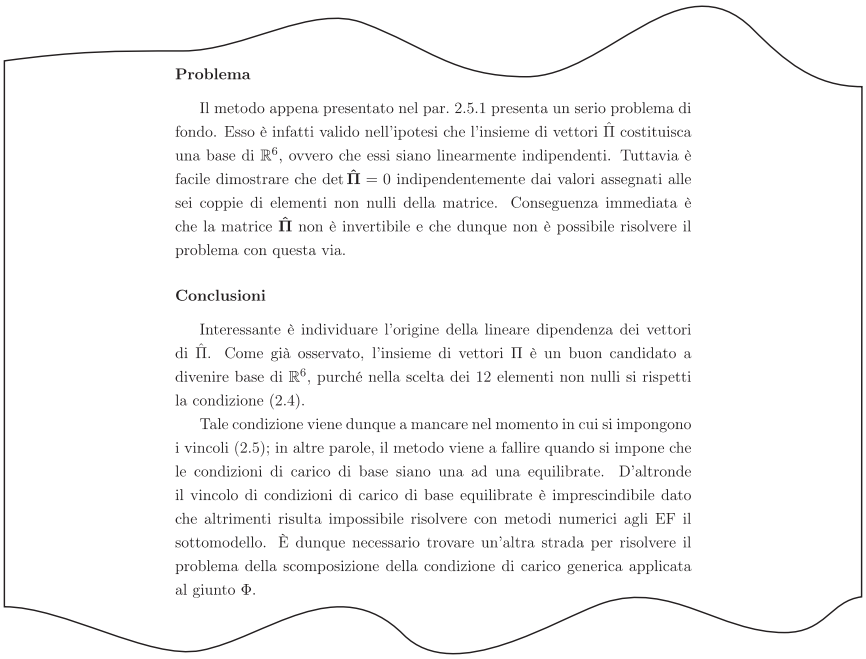
```
\newcommand{\fncyfront}{%
```

28. See [22] for a list of these commands.

29. `[applemac]` corresponds to the MacOSRoman encoding which is used by default by Mac OS 9 and Mac OS X. It is however possible to use other encodings depending on the editor used. For example TeXShop allows to save files with every encoding (MacOSRoman by default, but also Latin1, Latin9, Unicode, and all the others). The software deriving from *nix systems on the Macintosh platform (e.g. Emacs) usually uses the `[latin1]` encoding.



(a) without the indentfirst package



(b) with the indentfirst package

Figure 5: Example of indentation on the first paragraph.

```
    \fancyhead[RO]{{\footnotesize\rightmark}}
    \fancyfoot[RO]{\thepage}
    \fancyhead[LE]{\footnotesize{\leftmark}}
    \fancyfoot[LE]{\thepage}
    \fancyhead[RE,LO]{}
    \fancyfoot[C]{}
    \renewcommand{\headrulewidth}{0.3pt}}
\newcommand{\fncymain}{%
    \fancyhead[RO]{{\footnotesize\rightmark}}
    \fancyfoot[RO]{\thepage}
    \fancyhead[LE]{{\footnotesize\leftmark}}
    \fancyfoot[LE]{\thepage}
    \fancyfoot[C]{}
    \renewcommand{\headrulewidth}{0.3pt}}
```

These commands are then used in the text as follows:

```
\pagestyle{fancy}
\fncyfront
\frontmatter
...
\fncymain
\mainmatter
```

The `openright` class option might cause a blank page at the end of the chapter. The following command can be added to the preamble to avoid headers and footers on this blank page:

```
\makeatletter
\def\cleardoublepage{\clearpage\if@twoside
\ifodd\c@page
\else\hbox{}\thispagestyle{empty}\newpage
\if@twocolumn\hbox{}\newpage\fi\fi\fi}
\makeatother
```

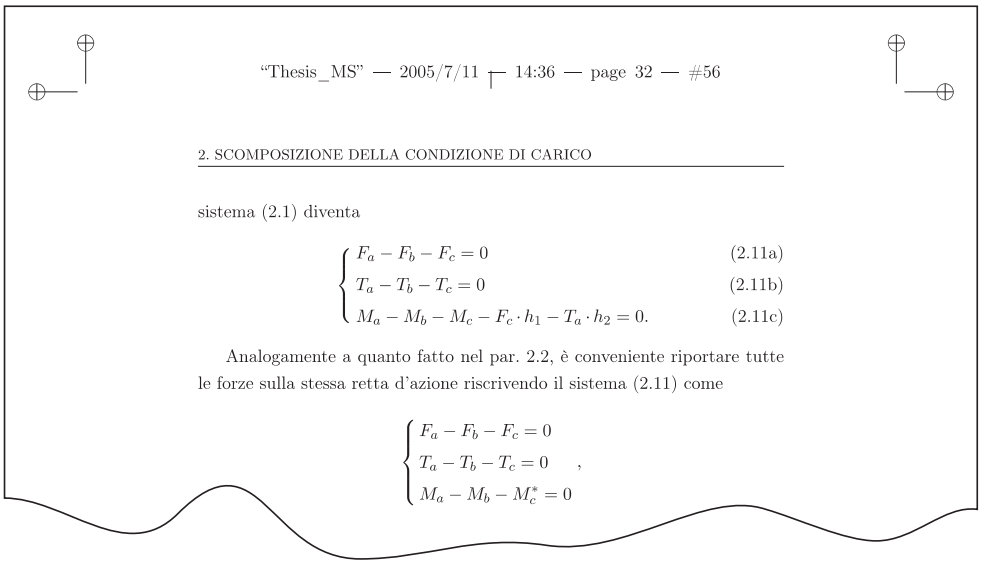


Figure 6: Example of page crop marks.

6.3.2 Page layout

University rules very often require a page layout different from that of the standard LaTeX classes. The layout could be changed using LaTeX primitive commands such as `\textwidth`, `\oddsidemargin`, etc., but this is not advisable for several reasons [5, 26]. A better solution is to use robust packages, such as layaureo,[30] which are very easy to use[31] but do not let the user define the layout. If none of these rigid packages produces the desired layout, the geometry package, which is very flexible, is recommended. The chngpage package permits changing single pages or paragraphs.

In order to bind the thesis it might be convenient to indicate where to cut the pages (Fig. 6). This can be easily done with the packages geometry and crop.

LaTeX tries by default to cover the entire page height and, if necessary, it ex-

30. Other packages such as widemargins, a4, and a4wide, could be used to modify the layout but they are not suggested because they are obsolete.

31. The layaureo package provides two layouts (with and without the `big` option) and allows to easily set the binding space with the `binding` command.

pands the space between paragraphs, list items, and so on. This behavior can be disabled with the `\raggedbottom` command[32] which leaves empty space at the bottom of pages if necessary. In order to improve page coverage it is possible to let the mathematical `display` environments break across two pages with the `\allowdisplaybreaks` command.

6.3.3 Line spacing

University rules often require a line spacing different from single spacing (which is the LaTeX default). There are many ways to modify the line spacing [26] but the best one is to use the setspace package. It provides three predefined line spacings with the commands `\singlespacing`, `\onehalfspacing`, and `\doublespacing`. If a different spacing is required then the `\setstretch{baselinestretch}` command can be used in the preamble to set the `baselinestretch` appropriately.

6.4 The style

6.4.1 Fonts

The T1 encoding, which is the new standard for LaTeX, should always be used. This encoding is not the default yet to guarantee backward compatibility, but can easily be selected with the command

```
\usepackage[T1]{fontenc}
```

Some problems, such as fuzzy fonts, might arise when visualizing the PDF [5]. The cm-super font is a simple solution to this problem since it provides a PostScript Type 1 font with the same shape as cm and tc families with several improvements such as support for non-ASCII characters.[33] In addition, the latin modern family is a vastly expanded computer modern, with even more support for non-ASCII characters than cm-super. Further details about this family can be found in its

32. The default behavior is obtained with the `\flushbottom` command.

33. http://en.wikipedia.org/wiki/ASCII

documentation and in [19]. When writing a scientific thesis, it is convenient to load the amsfonts package, which provides some mathematical fonts by the AMS, and the amsmath package, which provides several extensions to typeset mathematics. The relsize package permits modification the size of the font with relative commands (`\smaller` and `\larger`) in addition to the standard LaTeX commands.[34]

LaTeX users, who come from the What-You-See-Is-What-You-Get (WYSIWYG) world,[35] at least in the beginning, often wish to change font. This is probably due to the fact that the WYSIWYG software provides such bad topographic output, that the disappointed user often tries to improve it by changing the font. I suggest sticking with the LaTeX default font family, i.e the Computer Modern family which was developed by Donald Knuth, who also developed TeX. Changing a font with LaTeX is not as easy as with a WYSIWYG editor and for a good reason. When changing a font, four families (Serif, Sans-serif, `Typewriter`, and mathematical fonts such as $\mathbb{A}$, $\mathbf{A}$, $\mathcal{A}$, and $\mathfrak{A}$) which form a good typographic combination need to be chosen. Moreover, most fonts do not provide all the mathematical symbols and so can be used only in plain text.[36] If you must change the font, many packages are available (e.g. pxfonts, mathpazo, courier, eulervm, literat, lucida, pandora, mathptmx, helvet, courier, kerkis, kmath, qpxmath, qtxmath). Otherwise it is always possible to manually install a font as it is accurately explained in [19].

6.4.2 Chapter titles

The fncychap package permits modification of the format of chapter titles. The default format produced by the book class is reported in Fig. 8 while the command

```
\usepackage[Lenny]{fncychap}
```

was used in Fig. 7.

34. `tiny`, `scriptsize`, `footnotesize`, `small`, `normalsize`, `large`, `Large`, `LARGE`, `huge`, and `Huge`.
35. http://en.wikipedia.org/wiki/WYSIWYG
36. The Danish TUG hosts a web site that reports all the fonts that support mathematics (http://www.tug.dk/FontCatalogue/mathfonts.html) and other informartion can be found in [5].

The quotchap package can also be used to customize the titles, altough it offers fewer options than fncychap.

6.4.3 Lists

The enumerate package lets users modify the item numbering of enumerate-like environments. It can change the counter style[37] and the delimiter symbol.[38]

6.4.4 Minitoc

When the chapters have a very complex structure, it may be convenient to report a table of contents of the chapter on its first page (Fig. 7). These "minitocs" can be automatically produced by the minitoc package.

6.4.5 Epigraphs

The epigraph package lets users insert an epigraph in the first page of each chapter. An example is reported in Fig. 8.

6.4.6 Footnotes

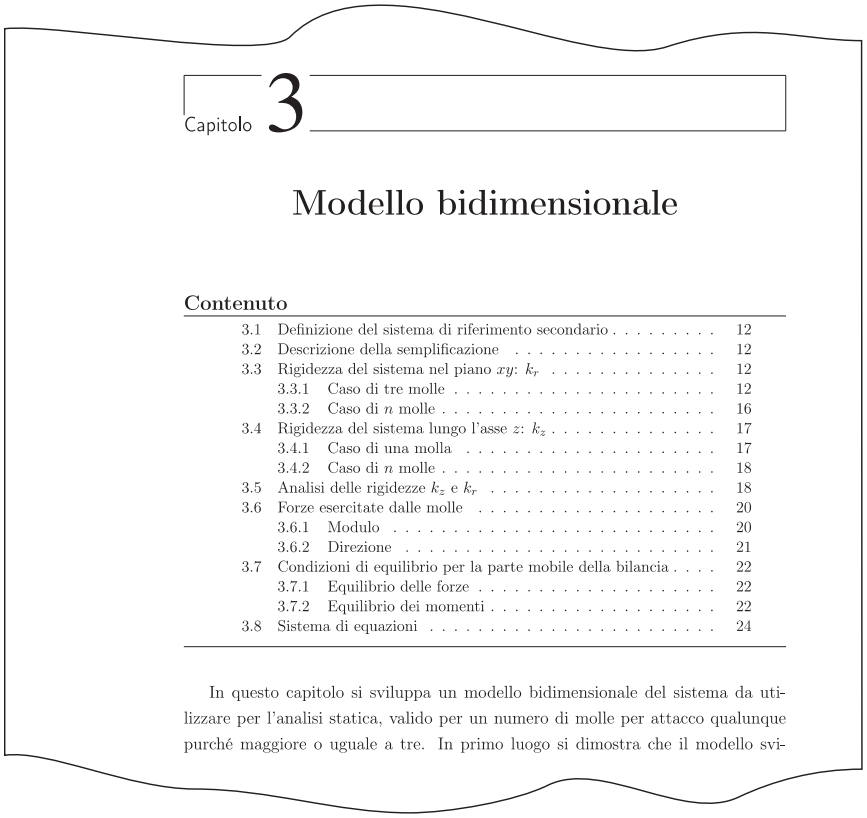
By default, LaTeX produces high quality footnotes. When it is really necessary, however, the user can change the footnote layout with some dedicated packages and commands. The footmisc package provides many options to control the footnotes, such as `bottom` which places the footnotes at the bottom of the page (Fig. 9).[39]

In order to prevent a single footnote from spreading over several pages, the user can set a high penalty to this behavior with the command

37. It is possible to use Arabic numerals (1,2,3,...), uppercase (I,II,III,...) and lowercase (i,ii,iii,...) Roman numerals, uppercase (A,B,C,...) and lowercase (a,b,c,...) Roman alphabet letters.

38. Every character can be used as a delimiter obtaining for example 1), 1., 1 –,...

39. LaTeX by default places the footnotes after the last line of the page thus, when a page is not fully covered, the footnotes are not at the bottom of the page.


Capitolo 3

Modello bidimensionale

Contenuto

In questo capitolo si sviluppa un modello bidimensionale del sistema da utilizzare per l'analisi statica, valido per un numero di molle per attacco qualunque purché maggiore o uguale a tre. In primo luogo si dimostra che il modello svi-

Figure 7: Example of a "minitoc".

```
\interfootnotelinepenalty=10000
```

The part of the page assigned to the footnotes can be controlled with the command

```
\dimen\footins=2cm
```

6.5 Mathematics

6.5.1 "Special" symbols

"Special" symbols are all the symbols that cannot be typed directly from the keyboard. For the mathematical symbols you should refer to the amssymb package

Figure 8: Example of an epigraph.

provided by the AMS. For all the other kinds of symbols there are specific packages that can be easily identified with [22].

6.5.2 Numbers

numprint is a very useful package to represent numbers. Among the other functions provided, it can automatically insert a separator every three figures and approximate a number. For example,

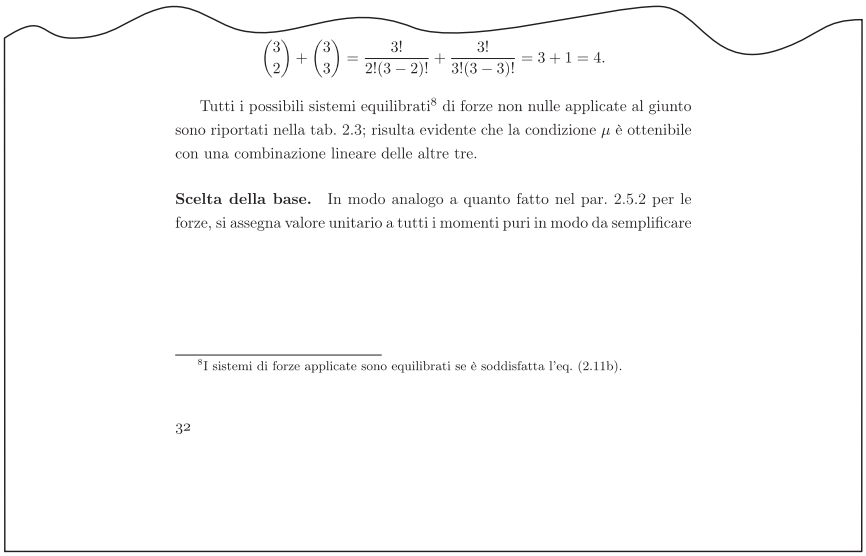
```
\numprint{2.742647826672E-01}
```

gives

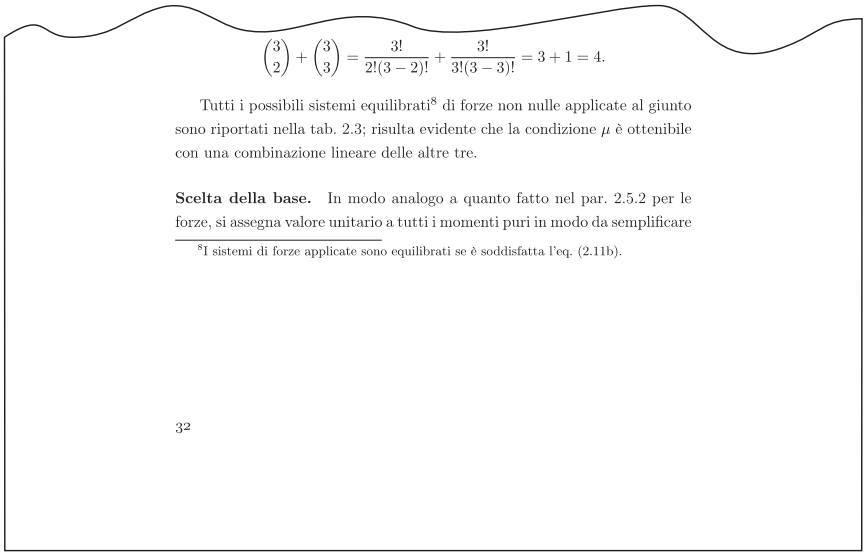
$2{,}743 \cdot 10^{-01}$

6.5.3 Units

To avoid formatting the units by hand, it is advisable to use the Slunits package. For example



(a) with the `bottom` option



(b) without the `bottom` option

Figure 9: Position of the footnotes.

```
\unit{32,1}{\micro\metre}
```

gives

32,1 µm

6.5.4 Other packages

The empheq package can be used to highlight mathematical environments. The theorem package can be used to customize theorem-like environments. The xfrac package lets users write fractions in the text and in the mathematics (e.g. 5/7).

6.5.5 System of equations

It is sometimes useful to group a system of equations with a curly brace. A convenient way to do it is by defining a new environment:

```
\newenvironment{sistema}
  {\left\lbrace\begin{array}{@{}l@{}}}
  {\end{array}\right.}
```

For example the following code

```
\[\begin{sistema}
x_1=\sigma_b^2-\sigma_a\\
x_2=\sigma_a^2-\sigma_b
\end{sistema}\]
```

produces

$$\begin{cases} x_1 = \sigma_b^2 - \sigma_a \\ x_2 = \sigma_a^2 - \sigma_b \end{cases}$$

Similar results can be obtained with the cases environment provided by the amsmath package.

6.6 Acronyms

Acronyms can be conveniently handled with the acronym package which can automatically generate hypertext links between the acronyms in the text and their

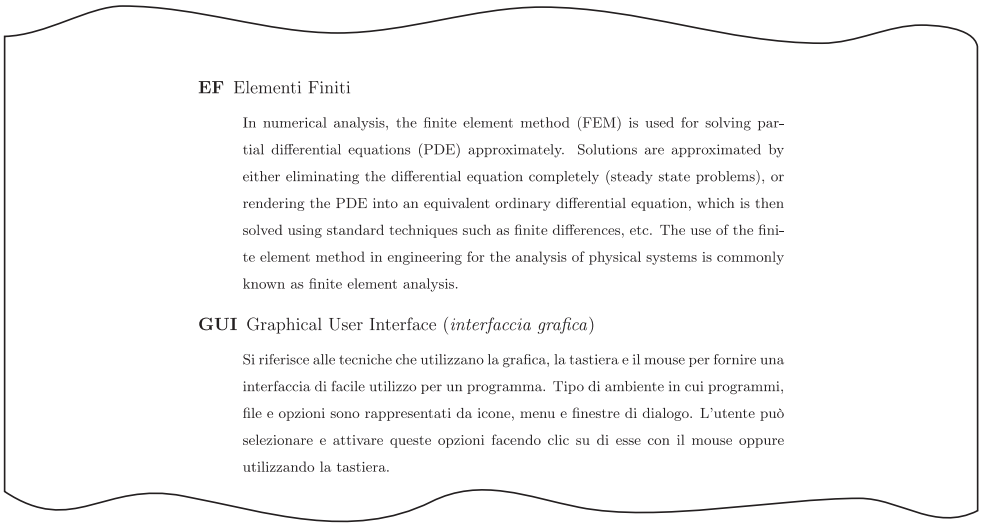


Figure 10: Example of list of acronyms.

definition in the list of acronyms. An example of a list of acronyms is reported in Fig. 10.

6.7 Codes and algorithms

The verbatim package can be used to add pieces of code to the text. The listings package, which recognizes many computer programming languages, allows a broader control of the code typographic style. Another alternative is the fancyvrb package.

The algorithm and algpseudocode packages can be used for the algorithms: the first one generates floating objects, the second one non-floating objects.

6.8 Cross-references

Sometimes it might be useful to use the `\ref` and `\pageref` commands together to refer to figures and table, especially when there are several pages between the object and the reference. For this purpose some authors use commands like

```
\newcommand{\fullref}[1]{\ref{#1} on page~\pageref{#1}}
```

However, it is not possible to know beforehand the position of the object and may happen that the `\pageref` refers to the same page. The varioref package defines the `\vref` command in order to take care of these exceptions. This package works together with babel to adapt to the language in use. For example

```
see Fig.~\vref{f5}
```

produces, depending on where is the figure, something like

see Fig. 3.1 on the next page

or

see Fig. 3.1 on page 24

As regards equations, the `\eqref{...}` command should be used instead of `(\ref{...})`. For example

```
defined in eq.~\eqref{e2}
```

produces

defined in eq. (3.6)

6.9 Reviewing the code

When reviewing the code, it is highly recommended to examine the `.log` file closely and to use the refcheck and showkeys packages to check how `\label` and `\ref` have been employed in the text. Moreover, the `draft` option of the `documentclass` can be used to highlight with black bands the points where the text goes out of the margins.

7 Useful websites

In addition to the guides and the manuals cited in the bibliography, the Web offers several resources to solve problems that might show up while writing a thesis with LaTeX.

Google provides, besides the traditional one,[40] a search engine dedicated to

40. http://www.google.com/

LaTeX.[41] The Usenet newsgroup comp.text.tex,[42] available also in other languages, contains a lot of information. The Comprehensive TeX Archive Network (CTAN),[43] which hosts most of the TeX and LaTeX material available in the Web, has a powerful search engine. Sarovar[44] is a large catalog of packages and programs connected with TeX and LaTeX. Among the types of search provided, the "topical" is particularly useful when you don't know the name of a package but you know what it should be able to do.

Many universities and research labs offers guides on LaTeX, usually targeted at beginners. We will just mention here Cambridge University,[45] Nottingham University,[46] Helsinki University,[47] and Emory University.[48] Moreover, David R. Wilkins released his book *Getting Started with LaTeX* in `html` format.[49]

References

[1] American Mathematical Society (2002). *AMS-LaTeX User's Guide*. URL ftp://ftp.ams.org/pub/tex/doc/amsmath/amsldoc.pdf.

[2] M. Baudoin (1997). *Apprends LaTeX!* URL http://tex.loria.fr/general/apprends-latex.pdf.

[3] P. Daly (1998). *Graphics and Colour with LaTeX*. URL http://tex.loria.fr/graph-pack/grf/grf.pdf.

41. http://directory.google.com/Top/Computers/Software/Typesetting/TeX/LaTeX/
42. http://groups.google.com/group/comp.text.tex
43. http://www.ctan.org/
44. http://texcatalogue.sarovar.org/
45. http://www-h.eng.cam.ac.uk/help/tpl/textprocessing/
46. http://www.cs.nott.ac.uk/TSG/manuals/latex/intro/
47. http://www.physics.helsinki.fi/~tfo_www/instr/latex-guide.html
48. http://www.emerson.emory.edu/services/latex/latex2e/latex2e_toc.html
49. http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/

[4] A. Diller (1999). *LaTeX Line by Line: Tips and Techniques for Document Processing*. John Wiley & Sons, 2nd edition.

[5] R. Fairbairns (2007). *The UK TeX FAQ*. URL http://www.ctan.org/tex-archive/help/uk-tex-faq/letterfaq.tex.

[6] S. Fear (2005). *Publication quality tables in LaTeX*. URL http://www.ctan.org/tex-archive/macros/latex/contrib/booktabs/booktabs.pdf.

[7] P. Flynn (2005). *A beginner's introduction to typesetting with LaTeX*. URL http://ctan.tug.org/tex-archive/info/beginlatex/.

[8] M. Goossens, F. Mittelbach, and A. Samarin (2004). *The LaTeX Companion*. Addison-Wesley, 2nd edition.

[9] M. Goossens, S. Rahtz, and F. Mittelbach (2007). *The LaTeX Graphics Companion: Tools and Techniques for Computer Typesetting*. Addison-Wesley, 2nd edition.

[10] G. Grätzer (1999). *First Steps in LaTeX*. Springer Verlag, 1st edition.

[11] G. Grätzer (2007). *More Math Into LaTeX*. Birkhauser, 4th edition.

[12] E. Gregorio (2007). *LaTeX: Breve guida ai pacchetti di uso più comune*. URL http://profs.sci.univr.it/~gregorio/breveguida.pdf.

[13] J. Hahn (1993). *LaTeX for Everyone: A Reference Guide and Tutorial for Typesetting Documents Using a Computer*. Prentice Hall.

[14] D. Higham and D. Griffiths (1997). *Learning LaTeX*. Society for Industrial and Applied Mathematics.

[15] ISO 5966 (1982). *Documentation – Presentation of scientific and technical reports*.

[16] D. Knuth (1984). *The TeXbook*. Reading, Massachusetts: Addison-Wesley.

[17] H. Kopka and P. Daly (1999). *A Guide to LaTeX – Document Preparation for Beginners and Advanced Users*. Addison-Wesley, 3rd edition.

[18] L. Lamport (1994). *LaTeX: A Document Preparation System, User's Guide and Reference Manual*. Addison-Wesley Professional, 2nd edition.

[19] P. Lehman (2004). *The Font Installation Guide*. URL http://www.ctan.org/tex-archive/info/Type1fonts/fontinstallationguide/fontinstallationguide.pdf.

[20] L. F. Mori (2007). Tables in LaTeX2ε: packages and methods. *The PracTeX Journal*, (4). URL http://www.tug.org/pracjourn/2007-1/mori/mori.pdf.

[21] T. Oetiker, H. Partl, I. Hyna, and E. Schlegl (2007). *The (Not So) Short Introduction to LaTeX2ε*. URL http://www.ctan.org/get/info/lshort/english/lshort.pdf.

[22] S. Pakin (2005). *The Comprehensive LaTeX Symbol List*. URL http://www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf.

[23] K. Reckdahl (2006). *Using Imported Graphics in LaTeX2ε*. URL http://www.ctan.org/tex-archive/info/epslatex.pdf.

[24] N. Talbot (2004). *Creating a PDF document using PDFLaTeX*. URL http://theoval.cmp.uea.ac.uk/~nlct/latex/pdfdoc/pdfdoc-a4.pdf.

[25] The Tutorial Team (2000). *On-line Tutorial on LaTeX*. Indian TeX Users Group. URL http://www.tug.org.in/tutorials.html.

[26] M. Trettin (2007). *An essential guide to LaTeX2ε usage — Obsolete commands and packages*. URL ftp://ftp.tex.ac.uk/tex-archive/info/l2tabu/english/l2tabuen.pdf.

[27] H. Voss (2007). *Mathmode*. URL www.ctan.org/tex-archive/info/math/voss/mathmode/Mathmode.pdf.

[28] H. Voss (2007). *Rotating Text, Tabulars and Images*. URL http://perce.de/LaTeX/PDF/rotating.pdf.