



SAMPLE THESIS CREATED BY USING L_YX

By
Ahmed Mohamed Rashed Desoki

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE
in
Aerospace Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
July, 2017 - Version 1.0.1

Proudly created by

Except for the figures created by Matlab¹, this thesis has been created by *open source software* (OSS) packages. Special thanks go to the numerous generous developers behind the following projects:

GNU project free software, mass collaboration project aiming to give users freedom

L^AT_EX document markup language

T_EX Live cross-platform L^AT_EX distribution

MiK_TE_X L^AT_EX distribution for Windows

L_XX cross-platform L^AT_EX-based document preparation system

Beamer L^AT_EX class for creating presentation slides and handouts

Inkscape cross-platform vector graphics editor

T_EX Text Inkscape plugin for creating and editing L^AT_EX formulae

Other great projects I failed to mention . . .

Other software packages

Other software packages that greatly helped me during this research include:

Areca cross-platform incremental backup package

pdfcrop a Perl program for removing white margins of a pdf file; indispensable for exported Matlab figures

GoldenDict cross-platform feature-rich dictionary lookup program

¹For your information, NumPy + SciPi + Matplotlib + Spyder offer very competitive alternative to Matlab. For Windows, all these packages and more are distributed by *Python(x,y)*.

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Abstract

I'm Ahmed Mohamed Rashed Desoki, an assistant professor at Aerospace Engineering Department, Cairo University.

I created this thesis template to show you how you can create a professional thesis using Open Source Software (OSS). Chapters of this template themselves concisely explain the necessary background you need to know about L^AT_EX, L^AT_EX, floating figures and tables, equations, references management, vector graphics, Inkscape, including program codes and others.

I strongly urge you to prepare your thesis file from the very beginning of your research. This is invaluable since it enables you to immediately document and cite every piece of new information you learn. I strongly urge you to stick to immediate documentation and citation as you learn. Citation itself expresses the value of your writing. You will find your citations invaluable especially after you read and learn a lot. At this time you will really fail to remember from where you learned every information.

This template is hosted at <https://github.com/ahmed-rashed/ThesisTemplate>. Usage of this template is licensed under GNU GPLv3¹. If you just want to use this template, simply download it as a zip file using <https://github.com/ahmed-rashed/ThesisTemplate/archive/master.zip> and proceed. While you are using this template, if you faced problems, try hard to read, learn and dig for solutions by yourself. If you improved/corrected/debugged/extended this template, then please *clone* the template repository using **Git** by

```
$ git clone https://github.com/ahmed-rashed/ThesisTemplate.git
```

, and kindly² send me your modifications as a *pull request*. If you don't know what is **Git**, you can find concise explanation in chapter 10, or in [1].

Finally, foreign languages usually causes some problems to L^AT_EX documents. Arabic is not an exception. So if you faced a strange problem that you cannot solve, try disabling the Arabic parts of this thesis to check if the problem is related to the Arabic language³. To do so, just use the **Thesis_English.lyx** file. If disabling Arabic solved your problem, please try hard to find a solution and reactivate the Arabic again. **Arabic scientists cannot help their nations using any language other than Arabic.**

¹www.gnu.org/licenses/quick-guide-gplv3.en.html

²In fact, you have to share your improvements according to the GNU GPLv3 license.

³Mostly the problem is not specific to Arabic, but to several other languages as well.

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Acknowledgments

Thanks to the Allah who helped me completing this template. I ask him to accept it from me for the sake of his mercy.

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Nomenclature

DAG	Directed acyclic graph, page 45
GUI	Graphical User Interface, page 46
IDE	Integrated Development Environment, page 6
IRF	Impulse Response Function, page 15
MS	Microsoft, page 1
ode	ordinary differential equation, page 13
OSS	Open Source Software, page i
PR	Pull Request, page 42
RCS	Revision Control System, page 33
SCM	Source Code Management, page 33
SDOF	Single Degree Of Freedom, page 12
SHA-1	Secure Hash Algorithm 1, page 45
TF	Transfer Function, page 14
VCS	Vevision Control System, page 33

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Chapter 1

Word Processors; L^AT_EX vs MS Word

Usually there are two categories of word processing software packages; table 1.1

- What You See Is What You Get (WYSIWYG)
- What You See Is What You Mean (WYSIWYM)

Roughly, you can compare L^AT_EX to Word as you compare Matlab to Excel. Figure 1.1 visualizes the effort and time consumption needed.

By the way, if you are annoyed by the existence of table 1.1 and figure 1.1 at the following page, this is explained in <http://tex.stackexchange.com/questions/66293/strange-behaviour-with-figure-on-chapter-first-page>

WYSIWYG	WYSIWYM
Microsoft Word LibreOffice Writer AbiWord Calligra Words	\LaTeX LyX

Table 1.1: \LaTeX vs Microsoft Word

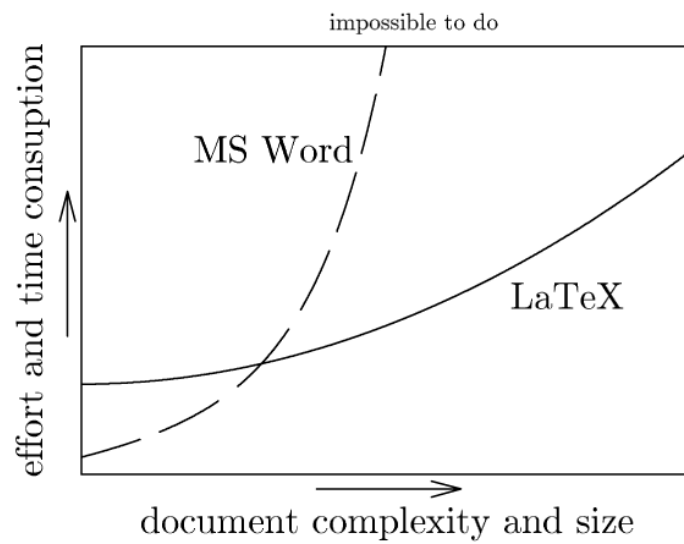


Figure 1.1: Effort and time consumption of MS Word as compared to \LaTeX .

Chapter 2

L^AT_EX; a Document Markup Language

L^AT_EX is a document markup language.

- Simply you can think of it as similar to HTML¹
- In order to create a document in L^AT_EX, a **.tex** file must be created using some **text editor**
- The **.tex** file is then **compiled** to produce the document
- L^AT_EX can generate several document formats including “pdf”

L^AT_EX is Free

Although being free is an advantage, but it is a drawback at the same time! Free implies:

- Slow download server
- No clean official documentation
- Several alternatives to do the same thing

However; L^AT_EX is very mature and widely used by professional/enterprise publishers

- Also it has a big user community
 - when you encounter a problem, google it. Most likely you will find others had encountered it and found a solution

2.1 L^AT_EX Editors

- To write C/C++ code, any text editor can be used
 - But using a good IDE can greatly ease your job
- L^AT_EX is similar
 - Any text editor is OK, but a dedicated L^AT_EX editor is strongly recommended
- A dedicated L^AT_EX editor

¹(HyperText Markup Language)

\LaTeX 2_ε Cheat Sheet

Document classes

`book` Default is two-sided.
`report` No `\part` divisions.
`article` No `\part` or `\chapter` divisions.
`letter` Letter (?).
`slides` Large sans-serif font.
 Used at the very beginning of a document:
`\documentclass{class}`. Use `\begin{document}` to start
 contents and `\end{document}` to end the document.

Common documentclass options

`10pt/11pt/12pt` Font size.
`letterpaper/a4paper` Paper size.
`twocolumn` Use two columns.
`twoside` Set margins for two-sided.
`landscape` Landscape orientation. Must use `dvips`
`-t landscape`.
`draft` Double-space lines.
 Usage: `\documentclass[opt,opt]{class}`.

Packages

`fullpage` Use 1 inch margins.
`anysize` Set margins: `\marginsize{l}{r}{t}{b}`.
`multicol` Use n columns: `\begin{multicols}{n}`.
`latexsym` Use \LaTeX symbol font.
`graphicx` Show image: `\includegraphics[width=x]{file}`.
`url` Insert URL: `\url{http://...}`.
 Use before `\begin{document}`. Usage: `\usepackage{package}`

Title

`\author{text}` Author of document.
`\title{text}` Title of document.
`\date{text}` Date.
 These commands go before `\begin{document}`. The
 declaration `\maketitle` goes at the top of the document.

Miscellaneous

`\pagestyle{empty}` Empty header, footer and no page num-
 bers.
`\tableofcontents` Add a table of contents here.

Document structure

`\part{title}` `\subsubsection{title}`
`\chapter{title}` `\paragraph{title}`
`\section{title}` `\subparagraph{title}`
`\subsection{title}`
 Use `\setcounter{secnumdepth}{x}` suppresses heading
 numbers of depth $> x$, where `chapter` has depth 0. Use a `*`, as
 in `\section*{title}`, to not number a particular item—these
 items will also not appear in the table of contents.

Text environments

`\begin{comment}` Comment (not printed). Requires `verbatim`
 package.
`\begin{quote}` Indented quotation block.
`\begin{quotation}` Like `quote` with indented paragraphs.
`\begin{verse}` Quotation block for verse.

Lists

`\begin{enumerate}` Numbered list.
`\begin{itemize}` Bulleted list.
`\begin{description}` Description list.
`\item text` Add an item.
`\item[x] text` Use x instead of normal bullet or number.
 Required for descriptions.

References

`\label{marker}` Set a marker for cross-reference, often of the
 form `\label{sec:item}`.
`\ref{marker}` Give section/body number of marker.
`\pageref{marker}` Give page number of marker.
`\footnote{text}` Print footnote at bottom of page.

Floating bodies

`\begin{table}[place]` Add numbered table.
`\begin{figure}[place]` Add numbered figure.
`\begin{equation}[place]` Add numbered equation.
`\caption{text}` Caption for the body.
 The *place* is a list valid placements for the body. `t=top`,
`b=bottom`, `p=separate page`, `!place` even if ugly.
 Captions and label markers should be within the environment.

Text properties

Font face

Command	Declaration	Effect
<code>\textrm{text}</code>	<code>\rmfamily text</code>	Roman family
<code>\textsf{text}</code>	<code>\sffamily text</code>	Sans serif family
<code>\texttt{text}</code>	<code>\ttfamily text</code>	Typewriter family
<code>\textmd{text}</code>	<code>\mdseries text</code>	Medium series
<code>\textbf{text}</code>	<code>\bfseries text</code>	Bold series
<code>\textup{text}</code>	<code>\upshape text</code>	Upright shape
<code>\textit{text}</code>	<code>\itshape text</code>	<i>Italic shape</i>
<code>\textsl{text}</code>	<code>\slshape text</code>	<i>Slanted shape</i>
<code>\textsc{text}</code>	<code>\scshape text</code>	SMALL CAPS SHAPE
<code>\emph{text}</code>	<code>\em text</code>	<i>Emphasized</i>
<code>\textnormal{text}</code>	<code>\normalfont text</code>	Document font
<code>\underline{text}</code>		<u>Underline</u>

The command (`tttt`) form handles spacing better than the
 declaration (`tttt`) form.

Font size

<code>\tiny</code>	<small>tiny</small>	\Large Large
<code>\scriptsize</code>	<small>scriptsize</small>	\LARGE LARGE
<code>\footnotesize</code>	<small>footnotesize</small>	
<code>\small</code>	<small>small</small>	\huge huge
<code>\normalsize</code>	<small>normalsize</small>	\Huge Huge
<code>\large</code>	<small>large</small>	

These are declarations and should be used in the form `\small`
`...`, or without braces to affect the entire document.

Verbatim text

`\begin{verbatim}` Verbatim environment.
`\begin{verbatim*}` Spaces are shown as `␣`.
`\verb!text!` Text between the delimiting characters (in
 this case `!'`) is verbatim.

Justification

Environment	Declaration
<code>\begin{center}</code>	<code>\centering</code>
<code>\begin{flushleft}</code>	<code>\raggedright</code>
<code>\begin{flushright}</code>	<code>\raggedleft</code>

Miscellaneous

`\linespread{x}` changes the line spacing by the multiplier x .

Text-mode symbols

Symbols

<code>&</code>	<code>\&</code>	<code>~</code>	<code>_</code>	<code>...</code>	<code>\ldots</code>	<code>•</code>	<code>\textbullet</code>
<code>\$</code>	<code>\\$</code>	<code>^</code>	<code>\^{}{}</code>	<code> </code>	<code>\textbar</code>	<code>\</code>	<code>\textbackslash</code>
<code>%</code>	<code>\%</code>	<code>~</code>	<code>\~{}{}</code>	<code>#</code>	<code>\#</code>	<code>§</code>	<code>\S</code>

Accents

<code>ò</code>	<code>\'o</code>	<code>ó</code>	<code>\'o</code>	<code>ô</code>	<code>\^o</code>	<code>õ</code>	<code>\^o</code>	<code>ö</code>	<code>\=o</code>
<code>ó</code>	<code>\.o</code>	<code>ô</code>	<code>\^o</code>	<code>õ</code>	<code>\c o</code>	<code>ö</code>	<code>\v o</code>	<code>ø</code>	<code>\H o</code>
<code>ç</code>	<code>\c c</code>	<code>ç</code>	<code>\d o</code>	<code>ø</code>	<code>\b o</code>	<code>ö</code>	<code>\t oo</code>	<code>æ</code>	<code>\oe</code>
<code>Ë</code>	<code>\OE</code>	<code>æ</code>	<code>\ae</code>	<code>Æ</code>	<code>\AE</code>	<code>ä</code>	<code>\aa</code>	<code>Å</code>	<code>\AA</code>
<code>ø</code>	<code>\o</code>	<code>Ø</code>	<code>\O</code>	<code>ı</code>	<code>\l</code>	<code>L</code>	<code>\L</code>	<code>ı</code>	<code>\i</code>
<code>j</code>	<code>\j</code>	<code>i</code>	<code>\i</code>	<code>ı</code>	<code>\i</code>				

Delimiters

<code>'</code>	<code>"</code>	<code>‘</code>	<code>{</code>	<code>[</code>	<code>(</code>	<code><</code>	<code>\textless</code>
<code>,</code>	<code>"</code>	<code>’</code>	<code>}</code>	<code>]</code>	<code>)</code>	<code>></code>	<code>\textgreater</code>

Dashes

Name	Source	Example	Usage
hyphen	–	X-ray	In words.
en-dash	--	1–5	Between numbers.
em-dash	---	Yes—or no?	Punctuation.

Line and page breaks

`\` Begin new line without new paragraph.
`*` Prohibit pagebreak after linebreak.
`\kill` Don't print current line.
`\pagebreak` Start new page.
`\noindent` Do not indent current line.

Miscellaneous

`\today` February 25, 2014.
`\sim` Prints `~` instead of `\^{}{}`, which makes `~`.
`~` Space, disallow linebreak (W.J.~Clinton).
`\@.` Indicate that the `.` ends a sentence when following
 an uppercase letter.
`\hspace{l}` Horizontal space of length l (Ex: $l = 20\text{pt}$).
`\vspace{l}` Vertical space of length l .
`\rule{w}{h}` Line of width w and height h .

Tabular environments

tabbing environment

`\=` Set tab stop. `\>` Go to tab stop.
 Tab stops can be set on “invisible” lines with `\kill` at the end
 of the line. Normally `\` is used to separate lines.

Figure 2.1: \LaTeX cheat sheet (*continued in the next page*)

tabular environment

```
\begin{array}[pos]{cols}
\begin{tabular}[pos]{cols}
\begin{tabular*}[pos]{cols}
```

tabular column specification

```
l      Left-justified column.
c      Centered column.
r      Right-justified column.
p{width} Same as \parbox[t]{width}.
@{decl} Insert decl instead of inter-column space.
|      Inserts a vertical line between columns.
```

tabular elements

```
\hline      Horizontal line between rows.
\cline{x-y} Horizontal line across columns x through y.
\multicolumn{n}{cols}{text}
           A cell that spans n columns, with cols column
           specification.
```

Math mode

For inline math, use $\backslash(\dots)$ or $\$...\$$. For displayed math, use $\backslash[...]$ or $\backslashbegin{equation}$.

```
Superscriptx  ^{x}      Subscriptx  _{x}
 $\frac{x}{y}$     \frac{x}{y}   $\sum_{k=1}^n$   \sum_{k=1}^n
 $\sqrt{x}$        \sqrt[n]{x}   $\prod_{k=1}^n$     \prod_{k=1}^n
```

Math-mode symbols

```
<= \leq      >= \geq      ≠ \neq      ≈ \approx
× \times     ÷ \div      ± \pm        · \cdot
° ~{\circ}   ° \circ     ′ \prime    … \cdots
∞ \infty    ¬ \neg      ∧ \wedge   ∨ \vee
⊃ \supset    ∀ \forall     ∈ \in      → \rightarrow
⊂ \subset    ∃ \exists     ∉ \notin   ⇒ \Rightarrow
∪ \cup       ∩ \cap     | \mid     ⇔ \Leftrightarrow
â \dot a    â \hat a    ā \bar a    ã \tilde a
α \alpha    β \beta     γ \gamma    δ \delta
ε \epsilon  ζ \zeta      η \eta       ε \varepsilon
θ \theta    ι \iota     κ \kappa     ϑ \vartheta
λ \lambda    μ \mu       ν \nu       ξ \xi
π \pi        ρ \rho      σ \sigma     τ \tau
υ \upsilon    φ \phi     χ \chi       ψ \psi
ω \omega     Γ \Gamma    Δ \Delta     Θ \Theta
Λ \Lambda     Ξ \Xi      Π \Pi        Σ \Sigma
Υ \Upsilon   Φ \Phi     Ψ \Psi       Ω \Omega
```

Bibliography and citations

When using BibTeX, you need to run latex, bibtex, and latex twice more to resolve dependencies.

Citation types

```
\cite{key}      Full author list and year. (Watson and Crick
1953)
\citeA{key}     Full author list. (Watson and Crick)
\citeN{key}     Full author list and year. Watson and Crick
(1953)
\shortcite{key} Abbreviated author list and year. ?
\shortciteA{key} Abbreviated author list. ?
\shortciteN{key} Abbreviated author list and year. ?
\citeyear{key}  Cite year only. (1953)
All the above have an NP variant without parentheses; Ex.
\citeNP.
```

BibTeX entry types

```
@article      Journal or magazine article.
@book         Book with publisher.
@booklet      Book without publisher.
@conference   Article in conference proceedings.
@inbook       A part of a book and/or range of pages.
@incollection A part of book with its own title.
@misc         If nothing else fits.
@phdthesis    PhD. thesis.
@proceedings  Proceedings of a conference.
@techreport   Tech report, usually numbered in series.
@unpublished  Unpublished.
```

BibTeX fields

```
address       Address of publisher. Not necessary for major
publishers.
author        Names of authors, of format ....
booktitle     Title of book when part of it is cited.
chapter       Chapter or section number.
edition       Edition of a book.
editor        Names of editors.
institution    Sponsoring institution of tech. report.
journal       Journal name.
key           Used for cross ref. when no author.
month         Month published. Use 3-letter abbreviation.
note          Any additional information.
number        Number of journal or magazine.
organization  Organization that sponsors a conference.
pages         Page range (2,6,9--12).
publisher     Publisher's name.
school        Name of school (for thesis).
series        Name of series of books.
title         Title of work.
type          Type of tech. report, ex. "Research Note".
volume        Volume of a journal or book.
year          Year of publication.
```

Not all fields need to be filled. See example below.

Common BibTeX style files

```
abbrv  Standard      abstract  alpha with abstract
alpha  Standard      apa      APA
plain  Standard      unsrt    Unsorted
```

The L^AT_EX document should have the following two lines just before $\backslash\end{document}$, where bibfile.bib is the name of the BibTeX file.

```
\bibliographystyle{plain}
\bibliography{bibfile}
```

BibTeX example

The BibTeX database goes in a file called file.bib, which is processed with bibtex file.

```
@String{N = {Na\~{t}ure}}
@Article{WC:1953,
  author = {James Watson and Francis Crick},
  title = {A structure for Deoxyribose Nucleic Acid},
  journal = N,
  volume = {171},
  pages = {737},
  year = 1953
}
```

Sample L^AT_EX document

```
\documentclass[11pt]{article}
\usepackage{fullpage}
\title{Template}
\author{Name}
\begin{document}
\maketitle

\section{section}
\subsection*{subsection without number}
text \textbf{bold text} text. Some math:  $2+2=5$ 
\subsection{subsection}
text \emph{emphasized text} text. \cite{WC:1953}
discovered the structure of DNA.
```

```
A table:
\begin{table}[!th]
\begin{tabular}{|l|c|r|}
\hline
first & row & data \\
second & row & data \\
\hline
\end{tabular}
\caption{This is the caption}
\label{ex:table}
\end{table}
```

The table is numbered $\backslash\ref{ex:table}$.
 $\backslash\end{document}$

Copyright © 2014 Winston Chang
<http://www.stdout.org/~winston/latex/>

Figure 2.1: (continued) L^AT_EX cheat sheet

- can highlight and auto complete L^AT_EX keywords
- has several L^AT_EX templates for several types of documents
- facilitates compiling and debugging
- ...
- Sample L^AT_EX editors are:
 - Texstudio**; cross-platform
 - Kile**; for Linux
 - and** many others

2.2 Porting a L^AT_EX Document

Usually L^AT_EX source files reference images and other external files. Hence, if you want to move/copy your L^AT_EX document to another computer, you have to move/copy all the referenced files as well.

2.3 Arabic Support

Thanks to¹ the “Arabi” package, Arabic and Farsi languages are supported with the “Babel” package.

However, since Arabic users are few, “Arabi” package is not mature enough and some minor bugs do exist. Googling about these bugs, usually you find the similar bugs do exist in other languages as well, and hence you can infer solutions/workarounds. During preparing this thesis, I have done my best to solve/work-around all the bugs I have faced.

2.4 Installing L^AT_EX

To install and use L^AT_EX, basically you need two things; (1) L^AT_EX implementation and (2) Integrated Development Environment (IDE).

For MS Windows users, proText² is a T_EX/L^AT_EX distribution that includes:

- MiK_T_EX: L^AT_EX Implementation for MS Windows
- TexStudio: cross-platform T_EX/L^AT_EX IDE

For Linux and MAC OS, T_EX Live is a cross platform L^AT_EX implementation³, and there is a wide range of IDE’s including TexStudio.

Keep Concentrating

Due to its WYSIWYM nature, I feel more concentrating while using L^AT_EX as compared to **Ms-Word**

¹Thanks to GOD at first of course.

²www.tug.org/protext/

³That is, it is a cross-platform alternative to MiK_T_EX.

Chapter 3

LyX; a Graphical Front-End to L^AT_EX

LyX is a graphical front-end to L^AT_EX

- You can think of the LyX-L^AT_EX relationship as similar to the Visual Studio-C++ compiler relationship
- Unlike L^AT_EX, LyX comes with tidy and very good documentation
- Also it has a big community, i.e.,
 - it is mature enough
 - when you encounter a problem, google it. Most likely you will find others had encountered it and found a solution

Keep your concentration

Due to its WYSIWYM nature, I feel very concentrating while using **LyX** as compared to **Ms-Word**.

3.1 Installing LyX

Windows installer is available at www.lyx.org/

There are two installer variants:

1. Installer (recommended)
This needs a pre-installed L^AT_EX distribution
2. Bundle
It includes a minimal L^AT_EX distribution

I recommend installing as follows:

1. Install Inkscape
 - Confirm path to inkscape.exe is added to the “PATH” environment variable
2. Install MiK_TE_X (or T_EX Live)

3. Install L^AT_EX (Installer option)
4. Modify L^AT_EX configurations to use Inkscape as graphics translator, as explained in figure 3.1. That is, Tools▷Preferences▷Converters
 - SVG -> EPS:** `inkscape --export-area-drawing $$i --export-eps=$$o`
 - SVG -> PDF (graphics):** `inkscape --export-area-drawing $$i --export-pdf=$$o`
 - SVG -> PNG:** `inkscape --export-area-drawing $$i --export-png=$$o`
5. Enable continuous spell checking
 - Tools▷Preferences▷Language Settings▷Spellchecker▷Spellcheck continuously

Linux packages are usually available in most Linux distributions' repositories

3.2 Learning L^AT_EX

Explore style-list, menus and toolbars

Help menu includes very good manuals

- Manuals themselves are L^AT_EX documents
 - So they are essentially very good L^AT_EX examples
- You may begin with:
 1. Introduction
 2. Tutorial
- Then if needed, read necessary sections of:
 1. User's Guide
 2. rest of manuals ...

lyx\examples folder contains wide variety of very good examples

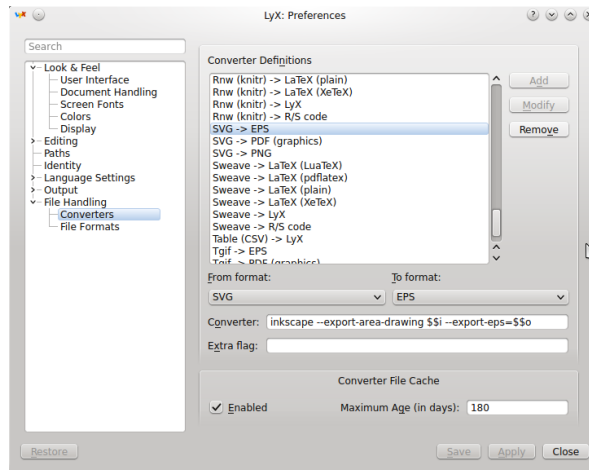
3.3 Porting a L^AT_EX Document

Similar to L^AT_EX files, L^AT_EX files usually reference images and other external files. Hence, if you want to move/copy your L^AT_EX document to another computer, you have to move/copy all the referenced files as well.

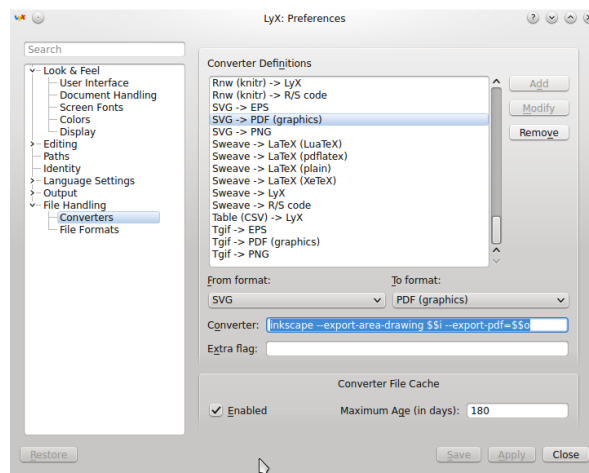
L^AT_EX greatly simplifies collecting the referenced files by the command L^AT_EX▷File▷Export▷L^AT_EX Archive

3.4 Arabic Support

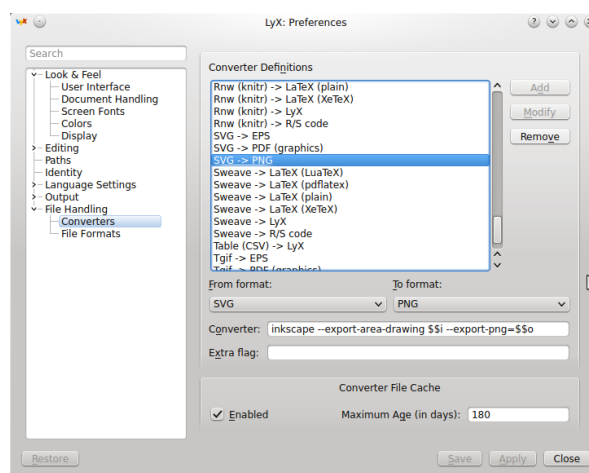
Arabic is supported in L^AT_EX, as shown in the following. For more details, refer to section 2.3.



(a) To convert svg to eps



(b) To convert svg to pdf



(c) To convert svg to png

Figure 3.1: Correcting svg converters in Inkscape

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Chapter 4

Floats, Figures, Tables and Equations

4.1 Concept of Floating Graphics, Tables

For those users familiar with MS Word, they expect figures and tables are placed where you put them. This however does not look professional. Therefore, \LaTeX , and consequently LyX , uses floats for placing figures and tables. Sample simple floating figures are figures [1.1](#), [7.1](#)

For more information about this topic, refer to [\[2\]](#) and [\[3, sec. 4.6\]](#).

4.2 Compound Figures

Figures composed of sub-figures can be created in by using the subcaption \LaTeX package. Sample compound figures are figures [2.1](#), [3.1](#), [4.1](#), [6.1](#), [6.2](#), [7.2](#) and [7.3](#).

4.2.1 Subfigure and Subtable

Have a look at figure [4.1](#).

4.3 Continued Floats

Figure [2.1](#) shows a sample float continued from a float to another.

4.4 Landscape Floats

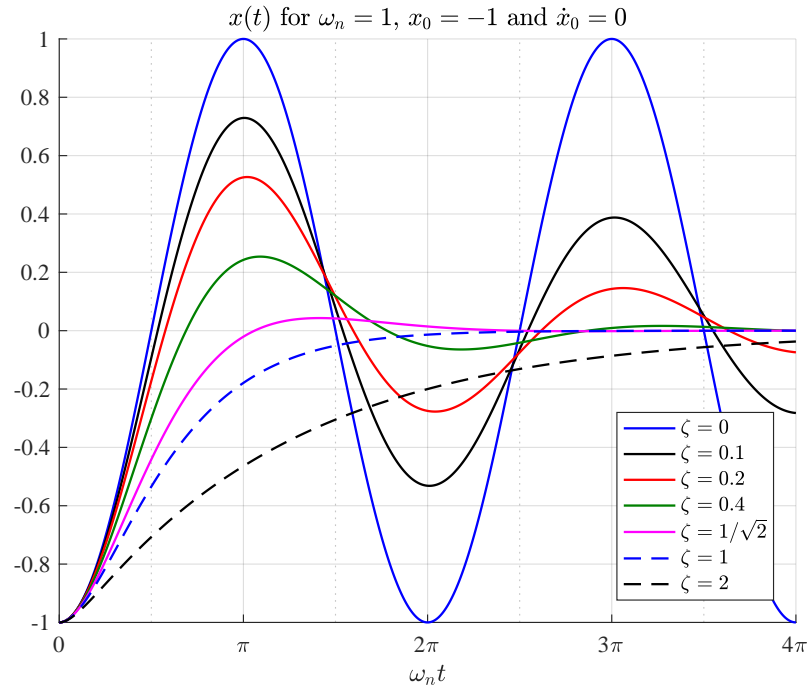
Have a look at figure [2.1](#).

4.5 Side-by-Side Facing Floats

Have a look at figures [6.1](#) and [6.2](#).

4.6 Free Inline Graphics without Captions

Have a look at graphics of chapter [10](#).



(a) Free vibration of a SDOF system

ρ_{ij}	$i = 1$	$i = 2$	$i = 3$	$i = 4$
$j = 1$	1.0000	-0.0000	-0.8328	-0.0010
$j = 2$	-0.0000	1.0000	-0.0000	-0.8328
$j = 3$	-0.8328	-0.0000	1.0000	-0.0000
$j = 4$	-0.0010	-0.8328	-0.0000	1.0000

(b) Correlation coefficient matrix

Figure 4.1: Figure composed of a subfigure and subtable

4.7 Tables

Table 4.1 shows a sample simple table, while table 4.2 shows a more complex table. Additional details are available in [3, sec. 4.5] and [2, chapter 2].

4.8 Equations

For details about equations, refer to [4]. The following is sample text with various types of equations.

4.8.1 SDOF Mass Spring System

Table 4.1: Table caption

	Conventional Transducer	This Transducer
Price	word word	word word
Size	word word	word word
Weight	word word	word word
Coupling	word word	word word
Material	word word	word word
Generation	word word	word word
Suitability	word word	word word
Restrictions	word word	word word
Action type	word word	word word

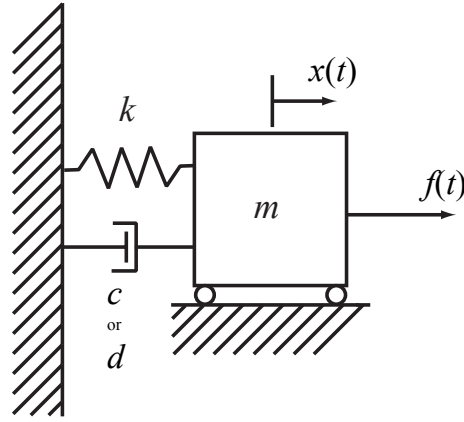


Figure 4.2: SDOF Mass Spring System

Governing Ordinary Differential Equation (ode)

$$m\ddot{x}(t) + c\dot{x}(t) + kx(t) = f(t) \quad (4.1)$$

Taking Laplace transform, the *ode* is transformed to the algebraic equation

$$m(s^2 X(s) - sx_0 - \dot{x}_0) + c(sX(s) - x_0) + kX(s) = F(s)$$

where $x_0 \equiv x(t=0)$ and $\dot{x}_0 \equiv \dot{x}(t=0)$.

Rearranging yields

$$(ms^2 + cs + k)X(s) - (ms + c)x_0 - m\dot{x}_0 = F(s) \quad (4.2)$$

Dividing by m yields

$$(s^2 + 2\zeta\omega_n s + \omega_n^2)X(s) - (s + 2\zeta\omega_n)x_0 - \dot{x}_0 = \frac{F(s)}{m} \quad (4.3)$$

where the non-dimensional parameters ω_n and ζ are the **natural frequency** and **damping ratio** defined as

$$\boxed{\omega_n \equiv \sqrt{\frac{k}{m}}} \quad \& \quad \boxed{\zeta \equiv \frac{c}{c_c}} \quad (4.4)$$

Table 4.2: Comparison between somethings

	Type 1	Type 2	Type 3	Type 4
Feature 1	words words words words words words words	words words words words words words words	words words words words words words words	words words words words words words words
Feature 2	words words words words words words words	words words words words words words words	words words words words words words words	words words words words words words words
Feature 3	words words words words words words words	words words words words words words words	words words words words words words words	words words words words words words words
Feature 4	words words words words words words words	words words words words words words words	words words words words words words words	words words words words words words words

where c_c is the *critical damping* defined as

$$c_c \equiv 2\sqrt{km} \quad (4.5)$$

By solving the algebraic equation (4.3), the response $X(s)$ is obtained as

$$X(s) = \frac{F(s)}{m(s^2 + 2\zeta\omega_n s + \omega_n^2)} + \frac{s x_0}{s^2 + 2\zeta\omega_n s + \omega_n^2} + \frac{2\zeta\omega_n x_0 + \dot{x}_0}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

or

$$X(s) = F(s) H(s) + \frac{s x_0}{s^2 + 2\zeta\omega_n s + \omega_n^2} + \frac{2\zeta\omega_n x_0 + \dot{x}_0}{s^2 + 2\zeta\omega_n s + \omega_n^2} \quad (4.6)$$

where $H(s)$ is the *Transfer Function* (TF) defined as

$$H(s) \equiv \frac{X(s)|_{\text{zero initial conditions}}}{F(s)} \quad (4.7)$$

$$= \frac{1}{ms^2 + cs + k} \quad (4.8)$$

$$= \frac{1}{m(s^2 + 2\zeta\omega_n s + \omega_n^2)} \quad (4.9)$$

$$= \frac{1}{m \left(s - \left(-\zeta\omega_n + \omega_n \sqrt{\zeta^2 - 1} \right) \right) \left(s - \left(-\zeta\omega_n - \omega_n \sqrt{\zeta^2 - 1} \right) \right)} \quad (4.10)$$

Assuming the roots of $H(s)$ are complex, the TF is written as

$$H(s) = \frac{1}{m \left(s - \left(-\zeta\omega_n + i\omega_n \sqrt{1 - \zeta^2} \right) \right) \left(s - \left(-\zeta\omega_n - i\omega_n \sqrt{1 - \zeta^2} \right) \right)} \quad (4.11)$$

or

$$H(s) = \frac{1}{m(s - (-\zeta\omega_n + i\omega_d))(s - (-\zeta\omega_n - i\omega_d))} \quad (4.12)$$

where

$$\omega_d \equiv \omega_n \sqrt{1 - \zeta^2} \quad (4.13)$$

Thus the response $x(t)$ can be obtained from equation (4.6) as

$$x(t) = \mathcal{L}^{-1} [X(s)] \quad (4.14)$$

where \mathcal{L}^{-1} denotes inverse Laplace transform.

Assuming the TF roots are complex, i.e., $\zeta < 1$, inverse Laplace transform tables yield

$$\begin{aligned} x(t) = & \mathcal{L}^{-1} [F(s) H(s)] \\ & + x_0 e^{-\zeta\omega_n t} \left(\cos(\omega_d t) - \frac{\zeta\omega_n}{\omega_d} \sin(\omega_d t) \right) \\ & + (2\zeta\omega_n x_0 + \dot{x}_0) e^{-\zeta\omega_n t} \frac{\sin(\omega_d t)}{\omega_d} \end{aligned} \quad (4.15)$$

Rearranging yields

$$\begin{aligned} x(t) = & \mathcal{L}^{-1} [F(s) H(s)] \\ & + e^{-\zeta\omega_n t} \left[x_0 \cos(\omega_d t) + (\zeta\omega_n x_0 + \dot{x}_0) \frac{\sin(\omega_d t)}{\omega_d} \right] \end{aligned} \quad (4.16)$$

or from the convolution property

$$\begin{aligned} x(t) = & (f * h)(t) \\ & + e^{-\zeta\omega_n t} \left[x_0 \cos(\omega_d t) + (\zeta\omega_n x_0 + \dot{x}_0) \frac{\sin(\omega_d t)}{\omega_d} \right] \end{aligned} \quad (4.17)$$

where

$$h(t) \equiv \mathcal{L}^{-1} [H(s)] = \frac{e^{-\zeta\omega_n t} \sin(\omega_d t)}{m \omega_d} \quad (4.18)$$

is the Impulse Response Function (IRF), and

$$(f * h)(t) \equiv \int_{-\infty}^{\infty} f(\tau) h(t - \tau) d\tau \quad (4.19)$$

$$= \int_0^t f(\tau) h(t - \tau) d\tau \quad , : f(t) = h(t) = 0 \quad \forall t < 0 \quad (4.20)$$

is the convolution of $f(t)$ and $h(t)$, assuming stable, linear, physically possible and time invariant system.

4.8.2 Inverse Laplace Transform Derivation

Using Laplace transform property, inverse Laplace can be obtained as

$$\frac{\Omega s}{(s^2 + \Omega^2)(s^2 + 2\zeta\omega_n s + \omega_n^2)} \xleftrightarrow{\mathcal{L}} \dot{y}(t) + y(0) \quad (4.21)$$

where $y(t)$ is the inverse Laplace transform of

$$\frac{\Omega}{(s^2 + \Omega^2)(s^2 + 2\zeta\omega_n s + \omega_n^2)}$$

previously derived as

$$y(t) = \frac{-2\zeta r \cos(\Omega t) + (1 - r^2) \sin(\Omega t) + r e^{-\zeta\omega_n t} \left[2\zeta \cos(\omega_d t) + \omega_n (2\zeta^2 - (1 - r^2)) \frac{\sin(\omega_d t)}{\omega_d} \right]}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \quad (4.22)$$

Thus

$$y(0) = \frac{-2\zeta r + 2\zeta r}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} = 0 \quad (4.23)$$

and

$$\begin{aligned} \dot{y}(t) &= \frac{\Omega}{\omega_n^2} \frac{2\zeta r \sin(\Omega t) + (1 - r^2) \cos(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \\ &\quad \times \left[\omega_d e^{-\zeta\omega_n t} \left(-2\zeta \sin(\omega_d t) + \omega_n (2\zeta^2 - (1 - r^2)) \frac{\cos(\omega_d t)}{\omega_d} \right) \right. \\ &\quad \left. - \zeta\omega_n e^{-\zeta\omega_n t} \left(2\zeta \cos(\omega_d t) + \omega_n (2\zeta^2 - (1 - r^2)) \frac{\sin(\omega_d t)}{\omega_d} \right) \right] \\ &= \frac{r}{\omega_n} \frac{(1 - r^2) \cos(\Omega t) + 2\zeta r \sin(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \\ &\quad \times \left[(\omega_n (2\zeta^2 - (1 - r^2)) - 2\zeta^2 \omega_n) \cos(\omega_d t) \right. \\ &\quad \left. + \left(-2\zeta\omega_d - \frac{\zeta\omega_n^2 (2\zeta^2 - (1 - r^2))}{\omega_d} \right) \sin(\omega_d t) \right] \\ &= \frac{r}{\omega_n} \frac{(1 - r^2) \cos(\Omega t) + 2\zeta r \sin(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r e^{-\zeta\omega_n t}}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \\ &\quad \times \left[-\omega_n (1 - r^2) \cos(\omega_d t) \right. \\ &\quad \left. + (-2\zeta\omega_d^2 - \zeta\omega_n^2 (2\zeta^2 - (1 - r^2))) \frac{\sin(\omega_d t)}{\omega_d} \right] \\ &= \frac{r}{\omega_n} \frac{(1 - r^2) \cos(\Omega t) + 2\zeta r \sin(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r e^{-\zeta\omega_n t}}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \\ &\quad \times \left[-\omega_n (1 - r^2) \cos(\omega_d t) \right. \\ &\quad \left. + \zeta\omega_n^2 (-2(1 - \zeta^2) - 2\zeta^2 + (1 - r^2)) \frac{\sin(\omega_d t)}{\omega_d} \right] \\ &= \frac{r}{\omega_n} \frac{(1 - r^2) \cos(\Omega t) + 2\zeta r \sin(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r e^{-\zeta\omega_n t}}{\omega_n^2 ((1 - r^2)^2 + (2\zeta r)^2)} \\ &\quad \times \left[-\omega_n (1 - r^2) \cos(\omega_d t) + \zeta\omega_n^2 (-2 + (1 - r^2)) \frac{\sin(\omega_d t)}{\omega_d} \right] \\ &= \frac{r}{\omega_n} \frac{(1 - r^2) \cos(\Omega t) + 2\zeta r \sin(\Omega t)}{(1 - r^2)^2 + (2\zeta r)^2} + \frac{r e^{-\zeta\omega_n t}}{\omega_n ((1 - r^2)^2 + (2\zeta r)^2)} \end{aligned}$$

$$\times \left[- (1 - r^2) \cos (\omega_{\text{d}} t) - \zeta \omega_{\text{n}} (1 + r^2) \frac{\sin (\omega_{\text{d}} t)}{\omega_{\text{d}}} \right] \quad (4.24)$$

Substituting equations (4.23) and (4.24) in (4.21) yields

$$\boxed{\frac{r}{\omega_{\text{n}}} \frac{(1 - r^2) \cos (\Omega t) + 2 \zeta r \sin (\Omega t) - e^{-\zeta \omega_{\text{n}} t} \left[(1 - r^2) \cos (\omega_{\text{d}} t) + \zeta \omega_{\text{n}} (1 + r^2) \frac{\sin (\omega_{\text{d}} t)}{\omega_{\text{d}}} \right]}{(1 - r^2)^2 + (2 \zeta r)^2} \xleftrightarrow{\mathcal{L}} \frac{\Omega s}{(s^2 + \Omega^2) (s^2 + 2 \zeta \omega_{\text{n}} s + \omega_{\text{n}}^2)}} \quad (4.25)$$

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Chapter 5

Reference Management Software

Reference management software [5] is citation management software or personal bibliographic management software is software for scholars and authors to use for recording and utilising bibliographic citations (references) [6]. Once a citation has been recorded, it can be used time and again in generating bibliographies, such as lists of references in scholarly books, articles and essays. The development of reference management packages has been driven by the rapid expansion of scientific literature. Among popular reference management software are:

JabRef, a BibTeX management cross-platform software for use with L^AT_EX/L_YX.

Endnote, a management software suitable for use with MS Word

Zotero, a cross-platform web-based management software suitable for L^AT_EX/L_YX, MS Word, LibreOffice and others.

Comparisons of these software are available in [7].

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Chapter 6

Vector Graphics

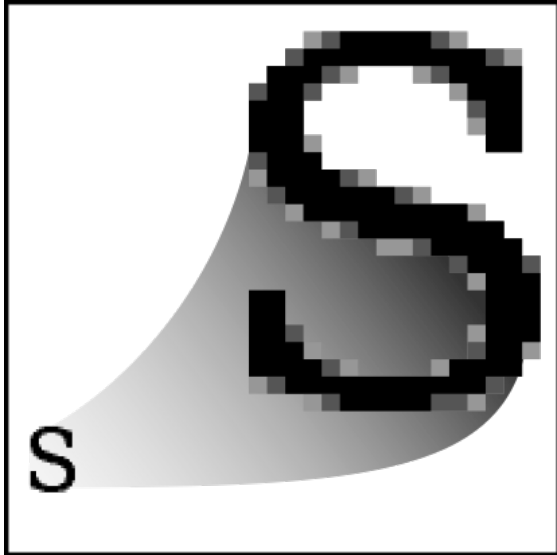
6.1 Raster vs Vector Graphics

Graphics Formats

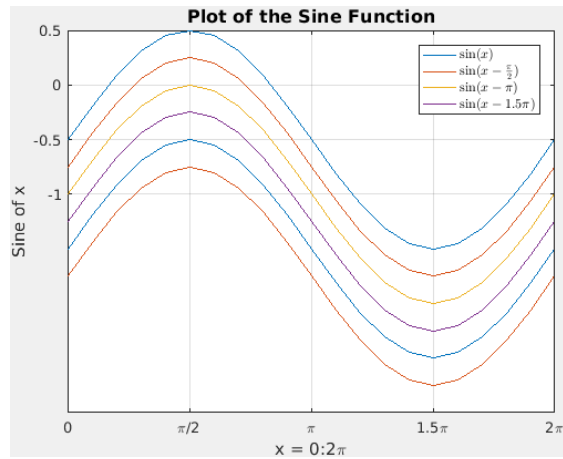
Raster		Vector	
.bmp	Uncompressed	.pdf	Compressed
.png	Loose-less compression	.eps	
.jpg	Lossy compression	.emf	Compatible with MS office
		.svg	
⋮		⋮	

6.2 Vector Graphics Editors

- Adobe Illustrator (*de facto* standard; bloated)
- Corel Draw (bloated)
- Inkscape (light, free, open source, cross-platform and popular; my favorite)
- LibreOffice Draw
- ...



(a) Letter



(b) Matlab figure

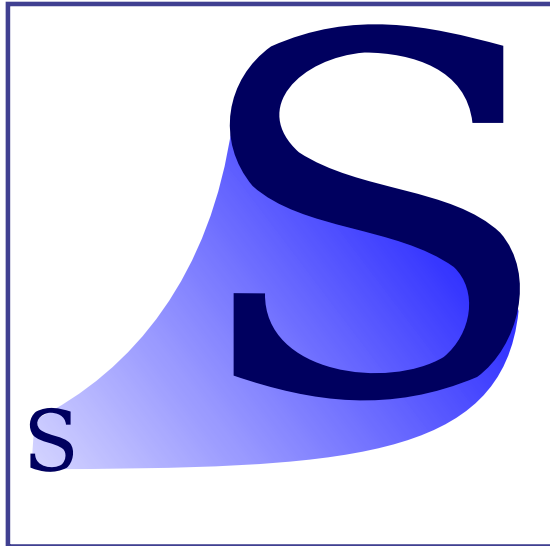


(c) Tiger

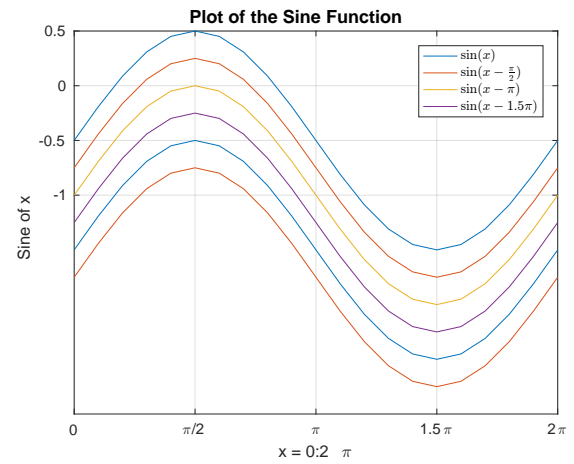


(d) Face

Figure 6.1: Sample raster graphics. This figure is forced to be on a left page for easier comparison with figure 6.2 on the opposite page.



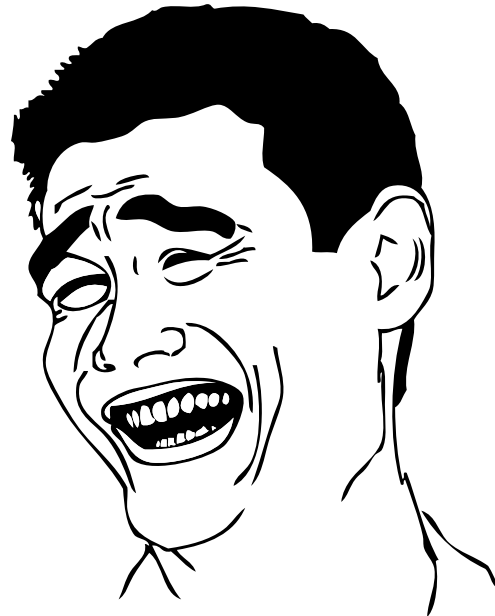
(a) Letter



(b) Matlab figure



(c) Tiger



(d) Face

Figure 6.2: Vector graphics version of figure 6.1

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Chapter 7

Inkscape; Free and Open Source Vector Graphics Editor

Inkscape Features

- Open source
- Cross platform
- Free
- Has a big community, i.e.,
 - it is mature enough
 - when you encounter a problem, google it. Most likely you will find others had encountered it and found a solution
- Much much powerful than Ms-Word or Ms-Power point sketching capabilities
- Has several plugins that greatly expand its capabilities

Inkscape Capabilities

Inkscape is based on bezier curves. That is, a curve is defined using four information, **start**, **end**, **start tangent** and **end tangent**.

- Additionally, you can draw and edit:
 - straight lines
 - circles/arcs/ellipses
 - text
 - \LaTeX formulas
 - function curves
 - ...

7.0.1 Import Graphics from pdf

You can import vector graphics from pdf files, and even edit them, as shown in [7.1](#).

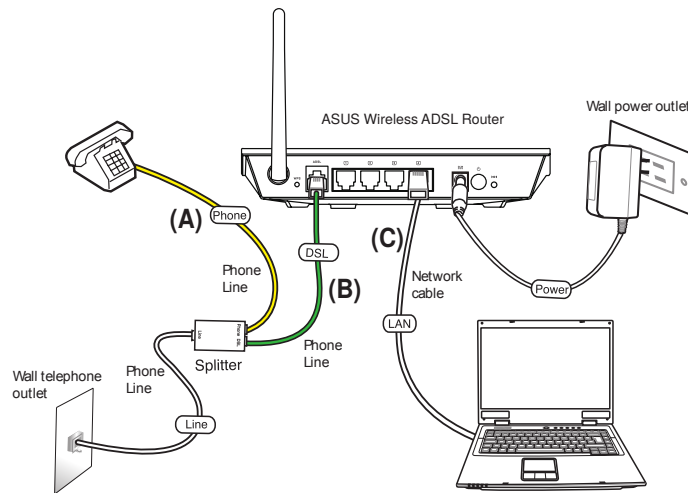


Figure 7.1: Vector graphic imported from the user guide of a home use ADSL router

7.1 Interesting Plug-ins

7.1.1 Function Plotter

- It is a built in plugins
- It uses bezier curves, same as Inkscape
- It calculates the function derivative and use it to adjust the curve slope
 - It produces very smooth curves using much less points than Matlab
 - You can still adjust/correct the curve manually

Figure 7.2 shows the plugin user interface, and the resulting curve. Figure 7.3 shows a more comprehensive example.

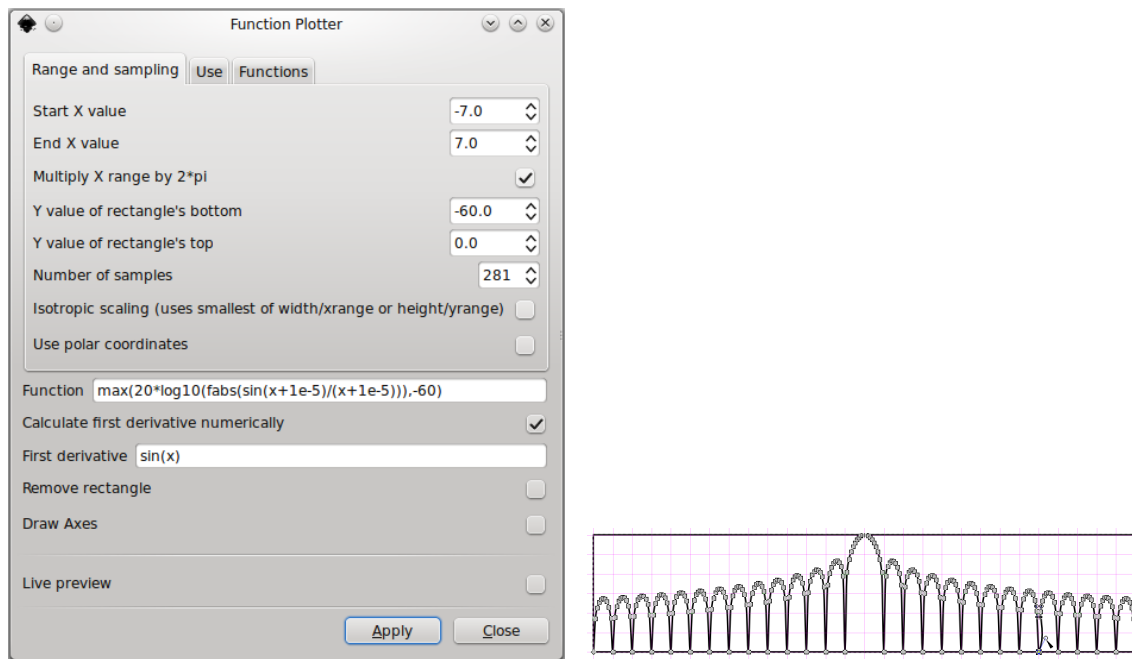
7.1.2 TextText

It allows you to write/edit $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ formulas inside Inkscape.

7.1.2.1 Installing TextText on MS Windows (all versions, including 32 & 64 bit)

Follow the instructions of <http://people.orie.cornell.edu/jmd388/design/guides/texttext.pdf>. That is:

1. Install Inkscape (the 32-bit version)
2. Install TextText from https://pav.iki.fi/_downloads/texttext-0.4.4.exe
3. Install 32 or 64 bit versions of ghostscript, imagemagick, pstoeedit
4. Make sure the following paths are added to the the “Path” environment variable:
 - C:\Program Files\gs\gs9.xx\lib



(a) Function Plotter user interface

(b) Curve generated by Function Plotter

Figure 7.2: The Function Plotter plugin

- C:\Program Files\gs\gs9.xx\bin
 - C:\Program Files\ImageMagick
 - C:\Program Files\ghostgum\pstoedit
5. Download the file <http://people.orie.cornell.edu/jmd388/design/guides/texttext.zip>
 - (a) Replace the “C:\Program Files (x86)\Inkscape\share\extensions\texttext.py” file with the file in the texttext.zip file
 - (b) Extract¹ the “site-packages.zip” file in the texttext.zip file to “C:\Program Files (x86)\Inkscape\python\Lib\site-packages”

7.1.2.2 Installing TexText on Linux

Installation on Linux is too easy and straight forward. Just follow the instructions at Tex-Text web page; <https://pav.iki.fi/software/texttext/>.

7.2 Learning Inkscape

- **Explore** menus and toolbars
- **Official manual** [8] is very good and detailed
 - Chapters 2 includes 10 examples
 - * The first 3 examples are enough for a good start

¹You must have administrator privileges to to this.

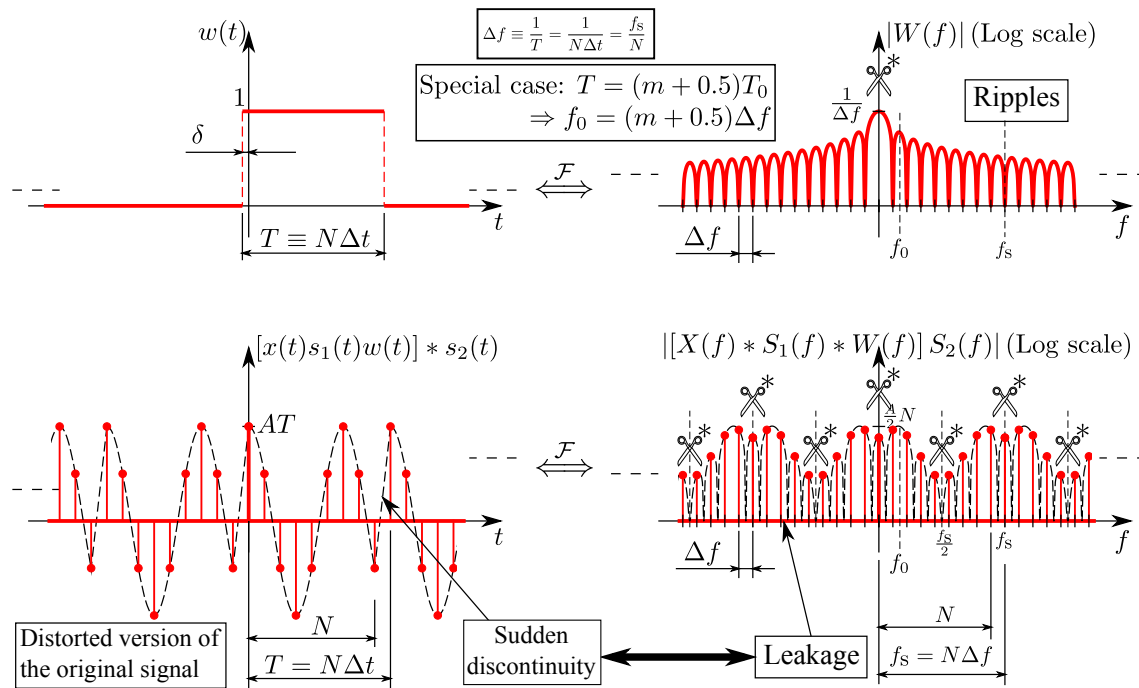


Figure 7.3: Figure illustrating the capabilities of “Function Plotter” and “TextText” plug ins.

– Chapters 5 explains editing

* Surf it fast

- **Help menu** includes tutorials, FAQ, ...
- <http://inkscapetutorials.org/>

Chapter 8

Including Program Codes

There is the listings \LaTeX package which greatly simplifies adding program codes. Details are available in [2, chapter 8]. For example, codes A.1 and A.2 are used to plot figure 4.1(a).

Code A.3 on the other hand exports a Matlab figure a pdf file and crops it by removing white margins. Cropping is accomplished by calling a Perl program called “pdfcrop”. This program, ships with both MiK \TeX and T \E X Live \LaTeX implementations. To use this program, Perl is needed to be installed¹.

¹“Strawberry Perl” is a sample open-source Perl implementation for Microsoft Windows.

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Chapter 9

About the Nomenclature

If you defined a nomenclature entry twice, it results in an error (Lonely `\item`—perhaps a missing list environment.).

9.1 Problems with Arabic

Nomenclature (and may be index too) sometimes causes problems in Arabic documents. As a workaround (assuming your thesis file name is “Thesis”):

1. `pdflatex` the Thesis.tex file twice (or as needed)
2. manually edit the *.nlo file and modify as follows

modify lines similar to this

```
\nomenclatureentry{aVI@[{VI}]\begingroup Visual  
Inspection\nomeqref {1.0}|nompageref}{\if@rlmain \I {1}\else  
\textLR {1}\fi }
```

to this

```
\nomenclatureentry{aVI@[{VI}]\begingroup Visual  
Inspection\nomeqref {1.0}|nompageref}{1}
```

3. Run the command

```
makeindex 'Thesis.nlo' -s nomencl.ist -o 'Thesis.nls'
```

4. `pdflatex` the Thesis.tex file once more (or as needed)

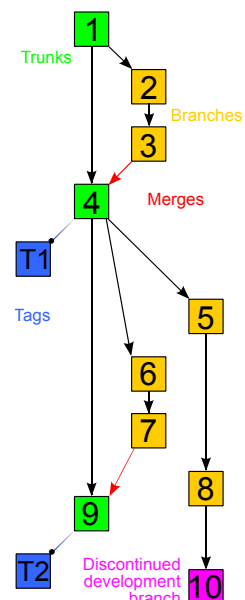
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Chapter 10

Version Control Using Git

Version¹ Control Systems (VCS) are examples of tools that help centrally manage the source code files and the changes to those files for a software project.

- It may be integrated with the IDE²
- Examples are:
 - Concurrent Versions System³ (CVS)
 - Subversion (SVN)
 - Git
- For information about git vs svn, visit (www.findbestopensource.com/article-detail/git-vs-subversion).



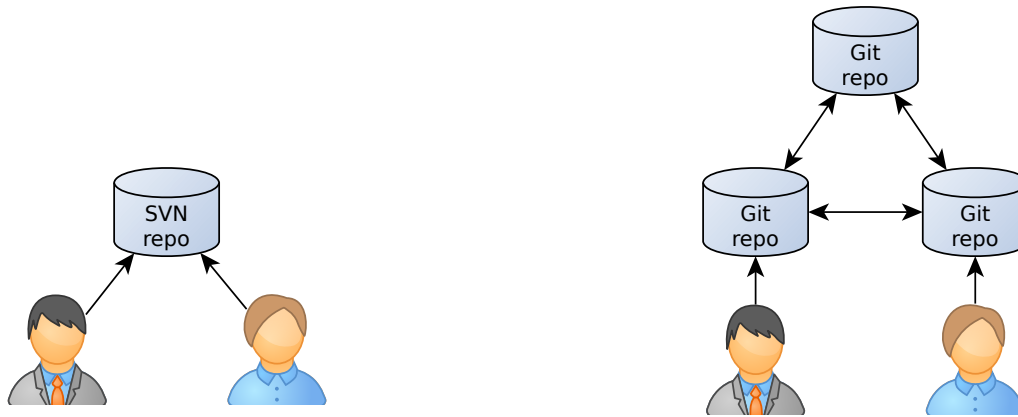
10.1 Centralized vs Decentralized Version Control

Centralized	Decentralized
CVS	Git
SVN	HG
...	...

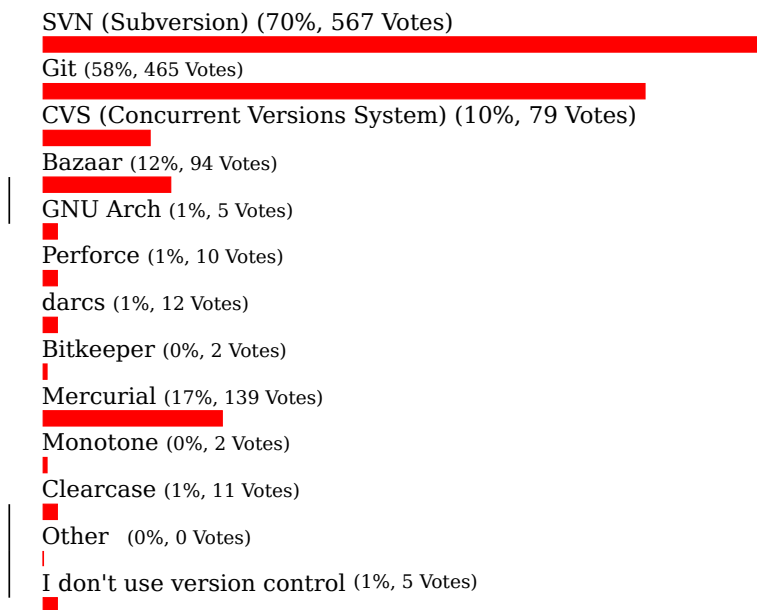
¹Also denoted as “Revision Control Systems (RCS)”, or Source Code Management (SCM) system.

²http://en.wikipedia.org/wiki/Comparison_of_revision_control_software

³Very old, widespread, but not so good



What version control systems are most important to you?



Total Voters: **808**

10.2 Introducing Git

Git is an open source program for tracking changes in text files. It was written by the author of the Linux operating system.

10.2.1 Git compared to other VCS

[<https://www.git-tower.com/learn/git/ebook/en/command-line/advanced-topics/merge-conflicts#start>]

- A great thing about having Git as your version control system is that it makes **merge**ing extremely easy: in most cases, Git will figure out how to integrate new changes.
- You can always undo a **merge** and go back to the state before a conflict occurred. You're always able to undo and start fresh.

- If you’re coming from another version control system like e.g. Subversion you might be traumatized: conflicts in **Subversion** have the (rightful) reputation of being incredibly complex and nasty. One reason for this is that Git, simply stated, works completely different in this regard than Subversion. As a consequence, Git is able to take care of most things during a *merge* - leaving you with comparatively simple scenarios to solve.
- Also, a conflict will only ever handicap yourself. It will not bring your complete team to a halt or cripple your central repository. This is because, in Git, conflicts can only occur on a developer’s local machine - and not on the server.

10.2.2 Git is Very Different

The first important thing to understand about Git is that it thinks about version control very differently than Subversion or whatever VCS tool you may be used to.

Theorem 10.1 (Forget theorem). *It is often easier to learn Git by trying to **forget** your assumptions about how version control works and try to think about it in the Git way.*

10.2.3 Installing Git

Check <https://git-scm.com/downloads>.

10.3 Understanding the Workflow of Git

Check figures [10.1](#), [10.2](#) and [10.3](#).

10.3.1 Git Cheat Sheet

Check figure [10.4](#).

10.3.2 Git Best Practices

Check figure [10.5](#).

10.4 Git Terminology Explained

The first step towards learning git is to understand the meaning of its terminology. The following terms [9] is ordered from the most basic to the less likely to use/hear-about.

Repository consists of two things:

“**.git**” **directory** is where Git stores the metadata and object database of the repository in a compressed format. It is what is copied when a repository is cloned.



The Basics

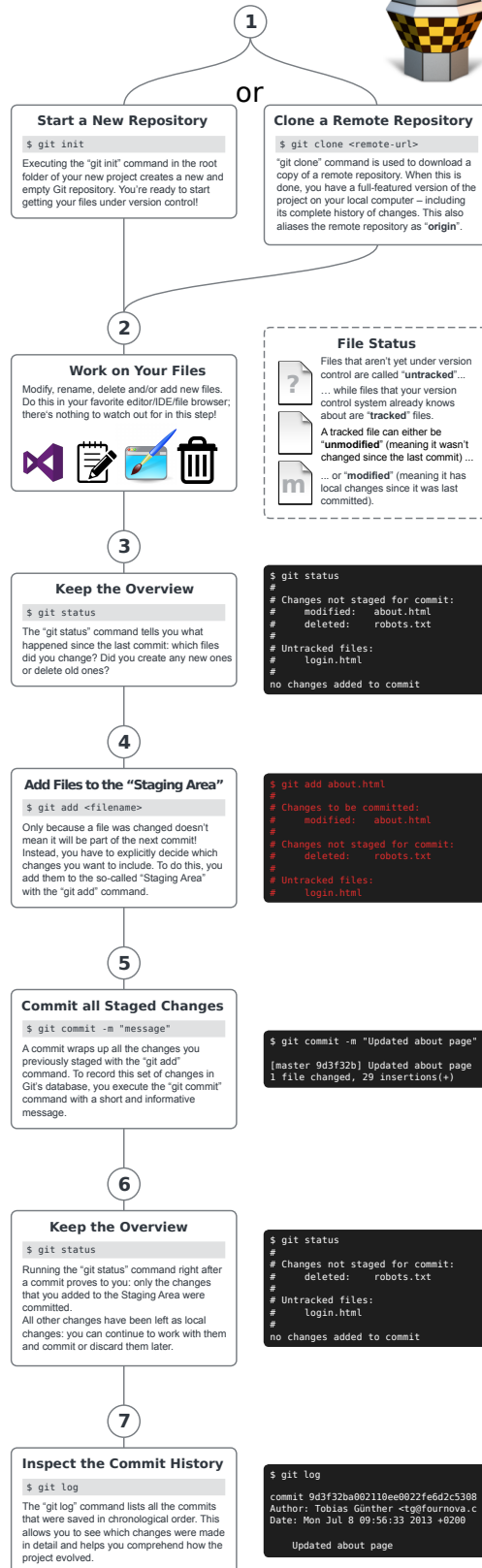


Figure 10.1: Git Basics [<https://www.git-tower.com/learn/cheat-sheets/vcs-workflow> with modifications]



Branching & Merging

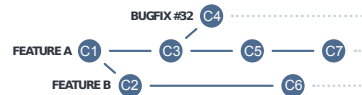
1

Start a New Feature

```
$ git branch <new-branch-name>
```

Whenever you start a new feature, a new experiment or a new bugfix, you should create a new branch. In Git, this is extremely fast and easy: just call "git branch <new-branch-name>" and you have a new, separate context. Don't be shy about creating new branches: it costs you nothing.

Understanding Branches



We often have to work on multiple things in parallel: feature A, bugfix #32, feature B... This makes it all too easy to lose track of where each change belongs. Therefore, it's essential to keep these contexts separate from each other.

Grouping related changes in their own context has multiple benefits: your coworkers can better understand what happened because they only have to look at code that really concerns them. And you can stay relaxed, because when you mess up, you mess up only this context. Branches do just this: they provide a context that keeps your work and your changes separate from any other context.

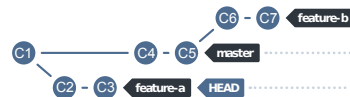
2

Switch Contexts

```
$ git checkout <new-branch-name>
```

To start working on a different context, you need to tell Git that you want to switch to it. You do this by "checking out" the branch with the "git checkout" command. Every commit you make – until you switch branches again – will be recorded in this branch and kept separate from your other contexts.

master Branch



master is the default name of the branch that is automatically created by \$ git init. If you dislike this name, you can rename using \$ git branch -m master new_branch_name

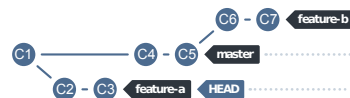
3

Integrate Changes

```
$ git merge <branch-to-integrate>
```

When your new feature is ready, you might want to integrate it into another branch (e.g. your production or testing branch). First, switch to the branch that is supposed to receive these changes. Then, call the "git merge" command with the name of the branch you want to integrate.

HEAD Branch



At each point in time, you can only work in one context – the context of the currently checked out branch (which is called the "HEAD" branch). Your project's working directory contains the files that correspond to this branch. When you check out a different branch (make it "HEAD"), Git replaces the files in your working directory with the ones that match this branch.

Figure 10.2: Git branching and merging [<https://www.git-tower.com/learn/cheat-sheets/vcs-workflow> with modifications]

Sharing Work via Remote Repositories

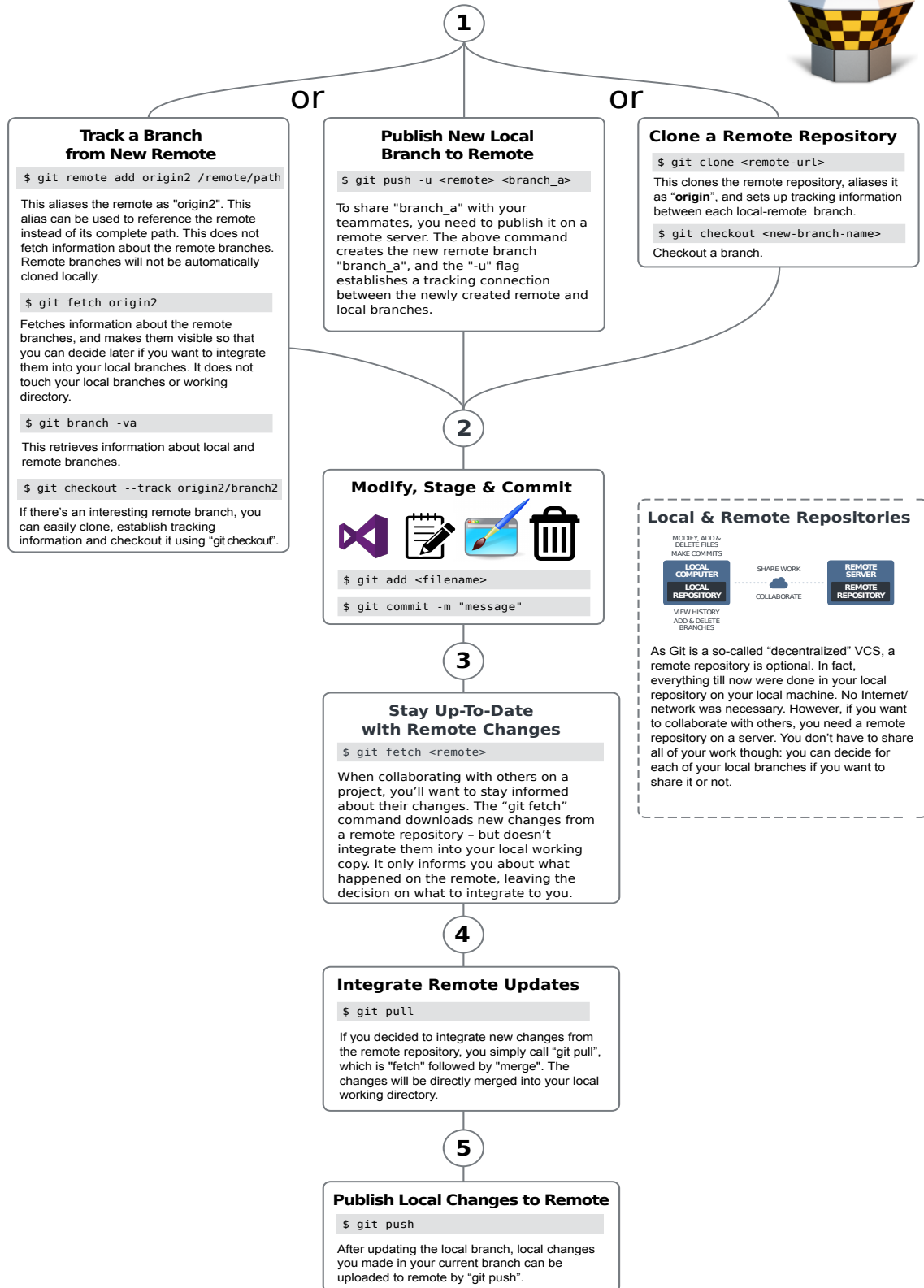


Figure 10.3: Git sharing work via remote repositories [<https://www.git-tower.com/learn/cheat-sheets/vcs-workflow> with modifications]

GITCHEAT SHEET

presented by **TOWER** > Version control with Git - made easy



CREATE

Clone an existing repository

```
$ git clone ssh://user@domain.com/repo.git
```

Create a new local repository

```
$ git init
```

LOCAL CHANGES

Changed files in your working directory

```
$ git status
```

Changes to tracked files

```
$ git diff
```

Add all current changes to the next commit

```
$ git add .
```

Add some changes in <file> to the next commit

```
$ git add -p <file>
```

Commit all local changes in tracked files

```
$ git commit -a
```

Commit previously staged changes

```
$ git commit
```

Change the last commit

Don't amend published commits!

```
$ git commit --amend
```

COMMIT HISTORY

Show all commits, starting with newest

```
$ git log
```

Show changes over time for a specific file

```
$ git log -p <file>
```

Who changed what and when in <file>

```
$ git blame <file>
```

BRANCHES & TAGS

List all existing branches

```
$ git branch -av
```

Switch HEAD branch

```
$ git checkout <branch>
```

Create a new branch based on your current HEAD

```
$ git branch <new-branch>
```

Create a new tracking branch based on a remote branch

```
$ git checkout --track <remote/branch>
```

Delete a local branch

```
$ git branch -d <branch>
```

Mark the current commit with a tag

```
$ git tag <tag-name>
```

UPDATE & PUBLISH

List all currently configured remotes

```
$ git remote -v
```

Show information about a remote

```
$ git remote show <remote>
```

Add new remote repository, named <remote>

```
$ git remote add <shortname> <url>
```

Download all changes from <remote>, but don't integrate into HEAD

```
$ git fetch <remote>
```

Download changes and directly merge/integrate into HEAD

```
$ git pull <remote> <branch>
```

Publish local changes on a remote

```
$ git push <remote> <branch>
```

Delete a branch on the remote

```
$ git branch -dr <remote/branch>
```

Publish your tag s

```
$ git push --tags
```

MERGE & REBASE

Merge <branch> into your current HEAD

```
$ git merge <branch>
```

Rebase your current HEAD onto <branch>
Don't rebase published commits!

```
$ git rebase <branch>
```

Abort a rebase

```
$ git rebase --abort
```

Continue a rebase after resolving conflicts

```
$ git rebase --continue
```

Use your configured merge tool to solve conflicts

```
$ git mergetool
```

Use your editor to manually solve conflicts and (after resolving) mark files resolved

```
$ git add <resolved-file>
```

```
$ git rm <resolved-file>
```

UNDO

Discard all local changes in your working directory

```
$ git reset --hard HEAD
```

Discard local changes in a specific file

```
$ git checkout HEAD <file>
```

Revert a commit (by producing a new commit with contrary changes)

```
$ git revert <commit>
```

Reset your HEAD pointer to a previous commit ...and discard all changes since then

```
$ git reset --hard <commit>
```

...and preserve all changes as unstaged changes

```
$ git reset <commit>
```

...and preserve uncommitted local changes

```
$ git reset --keep <commit>
```

Figure 10.4: Git Cheat Sheet [<https://www.git-tower.com/learn/cheat-sheets/git>]

VERSION CONTROL

BEST PRACTICES



COMMIT RELATED CHANGES

A commit should be a wrapper for related changes. For example, fixing two different bugs should produce two separate commits. Small commits make it easier for other developers to understand the changes and roll them back if something went wrong. With tools like the staging area and the ability to stage only parts of a file, Git makes it easy to create very granular commits.

TEST CODE BEFORE YOU COMMIT

Resist the temptation to commit something that you «think» is completed. Test it thoroughly to make sure it really is completed and has no side effects (as far as one can tell). While committing half-baked things in your local repository only requires you to forgive yourself, having your code tested is even more important when it comes to pushing/sharing your code with others.

USE BRANCHES

Branching is one of Git's most powerful features - and this is not by accident: quick and easy branching was a central requirement from day one. Branches are the perfect tool to help you avoid mixing up different lines of development. You should use branches extensively in your development workflows: for new features, bug fixes, ideas...

COMMIT OFTEN

Committing often keeps your commits small and, again, helps you commit only related changes. Moreover, it allows you to share your code more frequently with others. That way it's easier for everyone to integrate changes regularly and avoid having merge conflicts. Having few large commits and sharing them rarely, in contrast, makes it hard to solve conflicts.

WRITE GOOD COMMIT MESSAGES

Begin your message with a short summary of your changes (up to 50 characters as a guideline). Separate it from the following body by including a blank line. The body of your message should provide detailed answers to the following questions:

- > What was the motivation for the change?
- > How does it differ from the previous implementation?

Use the imperative, present tense («change», not «changed» or «changes») to be consistent with generated messages from commands like `git merge`.

AGREE ON A WORKFLOW

Git lets you pick from a lot of different workflows: long-running branches, topic branches, merge or rebase, `git-flow`... Which one you choose depends on a couple of factors: your project, your overall development and deployment workflows and (maybe most importantly) on your and your teammates' personal preferences. However you choose to work, just make sure to agree on a common workflow that everyone follows.

DON'T COMMIT HALF-DONE WORK

You should only commit code when it's completed. This doesn't mean you have to complete a whole, large feature before committing. Quite the contrary: split the feature's implementation into logical chunks and remember to commit early and often. But don't commit just to have something in the repository before leaving the office at the end of the day. If you're tempted to commit just because you need a clean working copy (to check out a branch, pull in changes, etc.) consider using Git's «Stash» feature instead.

VERSION CONTROL IS NOT A BACKUP SYSTEM

Having your files backed up on a remote server is a nice side effect of having a version control system. But you should not use your VCS like it was a backup system. When doing version control, you should pay attention to committing semantically (see «related changes») - you shouldn't just cram in files.

HELP & DOCUMENTATION

Get help on the command line

```
$ git help <command>
```

FREE ONLINE RESOURCES

<http://www.git-tower.com/learn>

<http://rogerdudler.github.io/git-guide/>

<http://www.git-scm.org/>

Figure 10.5: Git Best practices [<https://www.git-tower.com/learn/cheat-sheets/git>]

working directory normally contains the contents of the *HEAD* commit, plus any local changes made.

- Reverting to older *commit* replaces the *working directory* with the snapshot of this commit.
- Also checking out a *branch* replaces the *working directory* with the snapshot of the *HEAD* commit of the checked out branch.

working copy is a synonym to *working directory*

working tree is a synonym to *working directory*

staging area is generally a file in “*.git*” *directory* that stores information about what will be included into the next *commit*. It is also called *index*.

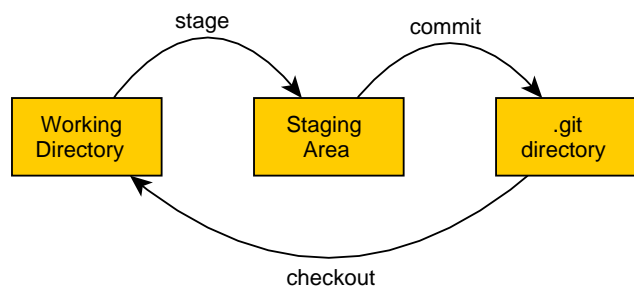
index is a synonym to *staging area*

stage adds files to the *staging area*, so that they are included in the next *commit*.

- Be warned that non-staged files may be removed (deleted) when checking out a *branch* or reverting to older an *commit*.

add is a synonym to *stage*.

commit ¹ record a snapshot of the current state of the *staging area*, marking a new version of your repository. Later on, you can revert the repository to any commit.



tag is most typically used to mark a particular *commit*.

head is a named reference to the last *commit* of a *branch*.

HEAD is a named reference to *head* of the *current branch*.

clone does the following:

1. creates a *local* copy of a *remote Repository*, including all of its *branches*,
 2. sets up tracking information² between each *local-remote* (upstream) *branch*
 3. *checkout* the *local* branch corresponding to the *remote*'s *current* branch.
- `$ git clone <remote-url>` automatically aliases *remote Repository* as *origin*.

¹In other other VCS's, the same thing is referred to as *revision* or *version*.

²This enables using `$ git push` and `$ git pull` commands without specifying further arguments identifying targeted local and remote branches.

- If you prefer another alias for the *remote Repository*, clone using `$ git clone -o remote_alias <remote-url>`

remote is a repository that is used to track the local repository but resides somewhere else. Teams are using remote repositories to share & exchange data: they serve as a common base where everybody can publish their own changes and receive changes from their teammates.

- Remote repository may be usual or *bare* repository.
- Remotes can be managed using `$ git remote` command. Remote data can be updated/synced using with/from *local* repository using *fetch*, *pull* and *push*.
- You can have several of remotes.
- To see more information about a particular remote, use `$ git remote show [remote-name]`

upstream refers to the *remote* with which the *local* syncs.

downstream refers to the *local*, as compared to *upstream*.

origin is the default name assigned to *remote* by `$ git clone`. If you dislike this name, you can rename using `$ git remote rename origin new_origin_name`

pull updates the *current local branch*, and hence the *working directory*, with the *upstream branch* modifications.

- `$ git pull` performs two operations: (1) *fetch* the *upstream branch* updates and (2) *merge* them into the *current local branch*.
- `$ git pull --rebase` performs two operations: (1) *fetch* the *upstream branch* updates and (2) *rebase* the latest *local commit* on top of the *upstream branch*. This is suitable for updating after a short time.

push uploads all the new *commits* from the *current local branch* to the corresponding *upstream branch*. If the upstream branch was a **direct** ancestor to the local branch, push completes. Otherwise, the push is rejected. In this case, you have to *pull* the *upstream branch* first before you can push.

- If the owner of the *local* repository does not have permission to *push* to *remote*, then *pushing local* to *remote* is not possible. In this case instead, the owner of the *local* repository sends a *pull request* to the owner of the *remote* repository.

pull request is a request from the owner of a *local* repository to the owner of the *remote* repository to pull his changes. *remote*'s owner can use *diff* to review the changes and may selectively accepted/rejected changes.

- If the owner of the *local* repository has permission to *push* to *remote*, he can instead directly *push local* to *remote*.
- *pull request* is an announcing method, and are not a feature of Git. So it depends on the hosting website¹ and has no Git command.

¹Such as [GitHub.com](https://github.com) and [BitBucket.org](https://bitbucket.org)

fetch fetches *branches* from a *remote Repository*, along with the objects necessary to complete their histories.

- Fetch will not touch any of your *local branches* or your *working directory*. It just downloads data from the specified *remote* and makes them visible so that you can decide if you want to integrate new changes into your *local Repository*.

diff is the difference in changes between two commits, or saved changes. The diff will visually describe what was added or removed from a file since its last commit.

branch is a way to request a parallel isolated *working directory*, *staging area*, and *commit* history, so that you test new experimental features without disturbing the main branch¹. A local branch that you create on your machine is kept private to you until you explicitly decide to publish it using *push*. This means that it's perfectly possible to keep some of your work private while sharing only certain other branches with the world.

checkout a branch means to switch to this branch, *replace*² the *working directory* with the snapshot of the *head* of this branch and update the *staging area* and *HEAD* to point to this branch.

master is the default name of the branch that is automatically created by `$ git init`. If you dislike this name, you can rename using `$ git branch -m master new_branch_name`

merge tries to merge a *branch* into the *current branch*. As a result, it creates a merge *commit* combining both *branches*. If there are merge conflicts, manual intervention may be required to complete the merge.

- Merge directly modifies files on the *current working directory*.
- Merge integrates a *branch*; not individual *commits*
- If the merged *branches* changed the same lines in that same file, or if one deleted it while the other modified it, Git simply cannot know what is correct. Git will then mark the file as having a *conflict* - which you'll have to solve before you can continue your work. More details are in [1, Dealing With Merge Conflicts].
- You can always undo a merge and go back to the state before a conflict occurred. You're always able to undo and start fresh.
- If the *branch* to be merged happens to be descendant of *HEAD*, *merge* will automatically perform *fast forward merge*, as depicted in figure 10.7.

rebase reapply a series of changes from a branch to a different base, as depicted in figure 10.6.

¹In many VCS tools, *branching* a somewhat expensive process, often requiring creating a new copy of the source code directory, which can take a long time for large projects. Therefore, Git's branching model is referred to as a "*killer feature*" that sets superior in the VCS community. This is because Git branches in incredibly lightweight way, making branching operations nearly instantaneous, and switching back and forth between branches generally just as fast. Unlike many other VCSs, Git encourages workflows that *branch* and *merge* often, even multiple times in a day.

²Non committed, staged or stashed files may be removed (deleted). Therefore, it is advisable to *commit/stage/stash* your modifications before checking out.

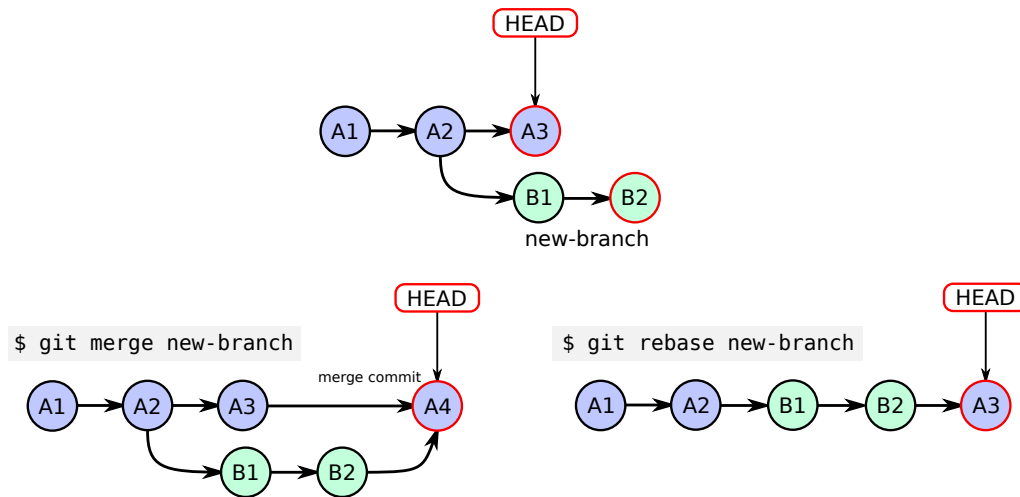


Figure 10.6: *merge* versus *rebase*

If the branch to be merged is descendant of HEAD, git merge would normally do fast forward merge.

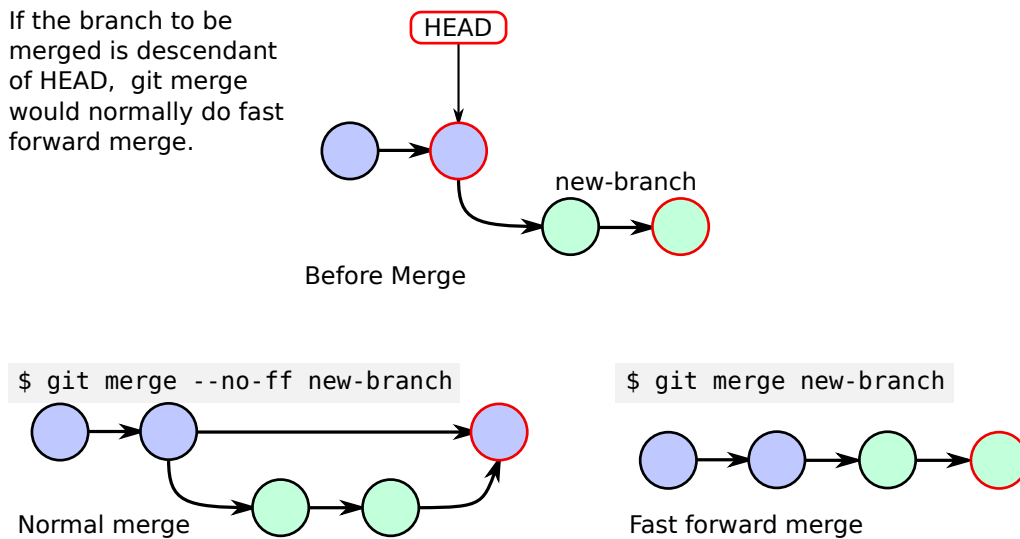


Figure 10.7: *fast forward merge*

Caution: *rebase* rewrites history. Therefore, *rebase* should only be used for cleaning up local commits. **Do not** *rebase* commits that have already been published to *upstream*.

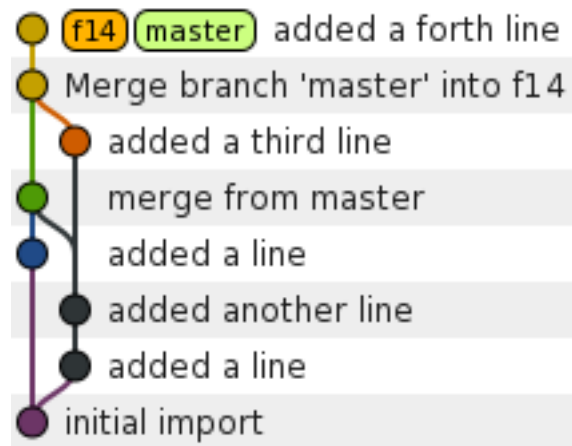
fast forward is a special type of *merge* that can occur while merging a *branch* that happens to be descendant of *HEAD*. In this case, *merge* will not make a new *merge commit*. Instead, *merge* will *rebase* the merged branch on top of *HEAD*, as depicted in figure 10.7. This is simply performed in this case just by pointing *HEAD* to the *head* of the merged branch.

- For more information, refer to [1, *Rebase as an Alternative to Merge*].

stash When you are developing some new feature and your work is not yet ready for a [commit](#), and want to checkout another branch to work on something else, *stash* is designed to help you in this situation. *stash* saves your local modifications away and reverts the working directory to match the [HEAD](#) commit. After finishing, you can return and re-apply the stashed work and can continue on it.

cherry pick means to extract the change introduced by an existing commit and to record it based on the tip of the current branch as a new commit.

DAG Directed acyclic graph.



resolve is fixing up manually what a failed automatic [merge](#) left behind.

blame describes the last modification to each line of a file, which generally displays the version, author and time. This is helpful, for example, in tracking down when a feature was added, or which commit led to a particular bug.

Fork fork is a copy of another repository that lives on your account. Forks allow you to freely make changes to a project without affecting the original. Forks remain attached to the original, allowing you to submit a pull request to the original's author to update with your changes. You can also keep your fork up to date by pulling in updates from the original.

SHA-1 (Secure Hash Algorithm 1) a cryptographic hash function used as a synonym for object name.

submodule is a repository inside another repository (the latter of which is called [superproject](#)).

superproject is a repository that references repositories of other projects in its working tree as [submodule](#). The superproject knows about the names of (but does not hold copies of) commit objects of the contained submodules.

Hook is a script that runs automatically every time a particular event occurs in a Git repository. Hooks let you customize Git's internal behavior and trigger customizable actions at key points in the development life cycle.

prune removes unreachable objects.

bare repository is intended to be solely used as a *remote* repository. That is, it is not used for working on files, but rather for sharing and exchanging code between developers. Hence, a bare repository contains no *working directory* and stores git version history in the root folder of the repository instead of in a “*.git*” *directory*. Customarily, bare repositories are given a “.git” extension. A blank bare repository can be created with `$ git init --bare`. Alternatively, it can be cloned from a local repository with `$ git clone --bare`.

10.5 Further Details

10.5.1 Submodules

Check [1, Submodules].

10.5.2 Undoing Things

Check [1, Undoing Things]

10.5.3 Dangerous Commands

- `$ git rm <filename>` unstage **and** delete a file. Use `$ git reset <filename>` instead to unstage the file.
- When checking-out a branch, non-committed, non-staged or non-stashed files may be removed (deleted). Therefore, it is advisable to *commit/stage/stash* your modifications before checking-out.

10.5.4 Further Reading

Reference [1] is very good for learning git. It is concise and very well written.

10.6 Git GUI

Check <https://git-scm.com/downloads/guis> for the complete list. Anyway, don’t expect any GUI can replace Git commands altogether.

10.6.1 Tower

Tower (www.git-tower.com) seems to be the best GUI. Its documentation, notably [1] are concise and clear. Tower can be installed only on Mac and Windows. It is however expensive and not open source.

10.6.2 GitKraken

GitKraken (www.gitkraken.com) on the other hand seems similar to *Tower*. It is free, cross platform but, however, not open source!

10.6.2.1 GitKraken Cheat Sheets

- GitKraken Cheat Sheet; www.gitkraken.com/resources/gitkraken-cheat-sheet
- GitKraken for GitHub Users Cheat Sheet; www.gitkraken.com/resources/gitkraken-github-cheat-sheet

10.6.2.2 Tips Using GitKraken

If you use remotes on [GitHub.com](https://github.com) or [BitBucket.org](https://bitbucket.org), make sure to authenticate as explained in <https://support.gitkraken.com/integrations/github> and <https://support.gitkraken.com/integrations/bitbucket>.

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Appendix A

Matlab Codes

Code A.1: SDOF_Free_Response_Visc_main

```
1 function SDOF_Free_Response_Visc_main()
2 clc
3 close all
4
5 set(groot,'DefaultAxesColorOrder',[0,0,1;0,0,0;1,0,0;0,0.5,0;1,0,1])
6 set(groot,'DefaultAxesLineStyleOrder','-|--|-.')
7 set(groot,'DefaultLineLineWidth',1);
8 set(groot,'DefaultAxesFontName','Times')
9
10 w_n=1;
11 x0=-1;
12 v0=0;
13
14 zeta_vec=[0,.1,.2,.4,1/sqrt(2),1,2];
15 legend_string={'$\zeta_{\omega}=0$', '$\zeta_{\omega}=0.1$', '$\zeta_{\omega}=0.2$', '$\zeta_{\omega}$
    =0.4$', '$\zeta_{\omega}=1/\sqrt{2}$', '$\zeta_{\omega}=1$', '$\zeta_{\omega}=2$'};
16
17 t_vec=linspace(0,4*pi,500);
18
19 figure
20 hold on
21 for n=1:length(zeta_vec)
22     x_vec=SDOF_Free_Response_Visc(w_n,zeta_vec(n),x0,v0,t_vec);
23     plot(w_n*t_vec,x_vec)
24 end
25
26 title('$x(t)$ for $\omega_{\omega}=1$, $x_{\omega}=-1$ and $\dot{x}_{\omega}=0$', '
    interpreter','latex');
27 xlabel('$\omega_{\omega}t$', 'interpreter','latex');
28 legend(legend_string,'interpreter','latex','Location','SouthEast');
29
30 grid on
31 ax=gca;
32 ax.XTick=0:pi:4*pi;
```

```

33 ax.XTickLabel={'0','\pi','2\pi','3\pi','4\pi'};
34 ax.XAxis.MinorTickValues=setdiff(0:pi/2:4*pi,0:pi:4*pi);
35 ax.XMinorGrid='on';
36 ax.XLim=[0,4*pi];
37
38 set(groot,'DefaultAxesColorOrder','remove')
39 set(groot,'DefaultAxesLineStyleOrder','remove')
40 set(groot,'DefaultLineLineWidth','remove');
41 set(groot,'DefaultAxesFontName','remove')
42
43 export_figure(gcf,'',{ 'SDOF_FreeResponse' })

```

Code A.2: function SDOF_Free_Response_Visc.m

```

1 function x_vec=SDOF_Free_Response_Visc(w_n, zeta, x0, x_dot_0, t_vec)
2
3 if zeta~=1
4     w_d=w_n*sqrt(1-zeta^2);
5     x_vec=exp(-zeta*w_n*t_vec).*(x0*cos(w_d*t_vec)+(zeta*w_n*x0+
        x_dot_0)*sin(w_d*t_vec)/w_d);
6 else
7     x_vec=exp(-w_n*t_vec).*(x0+(w_n*x0+x_dot_0)*t_vec);
8 end

```

Code A.3: function export_figure

```

function export_figure(fig_handle_vec, ...
                        Expand,filenames,resolution,pictureFormat) %
                        Optional arguments

if nargin<2
    Expand='';
end

if nargin<4
    resolution=600;
elseif isempty(resolution)
    resolution=600;
end

if nargin<5
    pictureFormat={'pdf'};
else
    if ~iscell(pictureFormat)
        error('pictureFormat must be cell array of strings.')
    end
end
end

```



```

printFlag=cell(size(pictureFormat));
for n=1:length(pictureFormat)
    if strcmpi(pictureFormat{n},'emf')
        if ispc
            printFlag{n}='meta';
        else
            error('Matlab cannot export emf except under Windows. ');
        end
    else
        printFlag{n}=lower(pictureFormat{n});
    end
end

if min(size(fig_handle_vec,1),size(fig_handle_vec,2))~=1,
    error('h must be 1D vector'),
end

if ~iscellstr(filenamees)
    error('filenamees must be a cell string of the same length as h_vec');
end

if nargin>2
    if length(fig_handle_vec)~=length(filenamees)
        error('h & filenamees must be of the same length');
    end
end

if ~isempty(Expand)
    if ischar(Expand)
        if (~strcmpi(Expand,'||') && ~strcmpi(Expand,'=='))
            error('you must input ''||'' or ''=='')
        end
    end
end

for i=1:length(fig_handle_vec)
    f_OriginalUnit=get(fig_handle_vec(i),'Units');
    set(fig_handle_vec(i),'papertype','A4');
    if ~isempty(Expand)
        if ischar(Expand)
            if strcmpi(Expand(1:2),'||')
                set(fig_handle_vec(i), 'PaperOrientation', 'portrait'
                );
            elseif strcmpi(Expand(1:2),'==')
                set(fig_handle_vec(i), 'PaperOrientation', 'landscape')
                ;
            end
        end
    end
end

```

```

end

if ischar(Expand)
    if strcmpi(Expand,'||') || strcmpi(Expand,'==')
        a=get(fig_handle_vec(i),'papersize');
        set(fig_handle_vec(i), 'PaperPositionMode', 'manual');
        set(fig_handle_vec(i),'PaperPosition',[0 0 a(1) a(2)])
        ;
        set(fig_handle_vec(i),'Units',get(fig_handle_vec(i),'
            PaperUnits'));
        set(fig_handle_vec(i),'Position',[0 0 a(1) a(2)]);
        set(fig_handle_vec(i),'Units',f_OriginalUnit);
        set(0,'CurrentFigure',fig_handle_vec(i)),
        drawnow
    else
        set(fig_handle_vec(i), 'PaperPositionMode', 'auto');
    end
elseif isnumeric(Expand)
    pos=get(fig_handle_vec(i),'PaperPosition');
    set(fig_handle_vec(i), 'PaperPositionMode', 'manual');
    set(fig_handle_vec(i), 'PaperPosition', [pos(1:2),pos(3:4)*
        Expand]);
end

end
end
end

for i=1:length(fig_handle_vec),
    for n=1:length(printFlag)
        if nargin<3
            print(['-r',int2str(resolution)], '-painters', ['-d',
                printFlag{n}], ['-f',int2str(double(fig_handle_vec(i)))
                ]);
            %print(['-r',int2str(resolution)], '-painters', ['-d',
                printFlag{n}], ['-f',int2str(get(fig_handle_vec(i),'
                Number'))]);
        else
            print(['-r',int2str(resolution)], '-painters', ['-d',
                printFlag{n}], ['-f',int2str(double(fig_handle_vec(i)))
                ],[filenames{i},['.',pictureFormat{n}]]]);
            % print(['-r',int2str(resolution)], '-painters', ['-d',printFlag{n}
                ], ['-f',int2str(get(fig_handle_vec(i),'Number'))],[filenames{i}
                ],['.',pictureFormat{n}]]]);
        end
    end
end
end

% %If "strawberry perl" and Miketex is installed

```

```

if nargin>=3 %&& ispc
    temp_env=getenv('LD_LIBRARY_PATH');
    setenv('LD_LIBRARY_PATH', '')
    for n=1:length(pictureFormat)
        if strcmpi(pictureFormat{n},'pdf')
            for i=1:length(fig_handle_vec),
                system(['pdfcrop"',filenames{i},'.pdf"',filenames{i}
                    },'.pdf"']);
            end

            break;
        end
    end
    setenv('LD_LIBRARY_PATH', temp_env)
end

```

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