

Doctoral Programme in Electronics and Electrical Engineering

# Title of the thesis

A possible subtitle

---

**Eddie Engineer**

© 2025

This work is licensed under a [Creative Commons](https://creativecommons.org/licenses/by-nc-sa/4.0/)  
“Attribution-NonCommercial-ShareAlike 4.0 International” license.



---

<b>Author</b>	Eddie Engineer
---------------	----------------

---

<b>Title</b>	Title of the thesis — A possible subtitle
--------------	---

---

<b>Doctoral programme in</b>	Electronics and Electrical Engineering
------------------------------	--

---

<b>Supervising professor</b>	Prof. Pirjo Professori
------------------------------	------------------------

---

<b>Thesis advisors</b>	Dr Alan Advisor, Ms Elsa Expert (MSc)
------------------------	---------------------------------------

---

<b>Collaborative partner</b>	Company or institute name (if relevant)
------------------------------	---

---

<b>Date of acceptance</b>	30 September 2025
---------------------------	-------------------

---

<b>Number of pages</b>	24+15	<b>Language</b>	English
------------------------	-------	-----------------	---------

---

### Abstract

The abstract is a short description of the essential contents of the thesis, usually in one paragraph: what was studied and how and what were the main findings.

For a Finnish thesis, the abstract should be written in both Finnish and English; for a Swedish thesis, in Swedish and English. The abstracts for English theses written by Finnish or Swedish speakers should be written in English and either in Finnish or in Swedish, depending on the student's language of basic education. Students educated in languages other than Finnish or Swedish write the abstract only in English. Students may include a second or third abstract in their native language, if they wish.

The abstract text of this thesis is written on the readable abstract page as well as into the pdf file's metadata via the `\thesisabstract` macro (see comment in this  $\text{\TeX}$  file above). Write here the text that goes onto the readable abstract page. You can have special characters, linebreaks, and paragraphs here. Otherwise, this abstract text must be identical to the metadata abstract text.

If your abstract does not contain special characters and it does not require paragraphs, you may take advantage of the `\abstracttext` macro (see the comment in this  $\text{\TeX}$  file below).

---

<b>Keywords</b>	For keywords choose, concepts that are, central to your, thesis
-----------------	---

---

---

**Tekijä** Eddie Engineer

---

**Työn nimi** Opinnäytteen otsikko — Opinnäytteen mahdollinen alaotsikko

---

**Tohtoriorhjelma** Elektroniikka ja sähkötekniikka

---

**Vastuuprofessori** Prof. Pirjo Professori

---

**Ohjaajat** TkT Alan Advisor, DI Elsa Expert

---

**Yhteistyötaho** Yhtiön tai laitoksen nimi (tarvittaessa)

---

**Hyväksymispäivämäärä** 30.9.2025

---

**Sivumäärä** 24+15

**Kieli** englanti

---

### Tiivistelmä

Tiivistelmä on lyhyt kuvaus työn keskeisestä sisällöstä usein yhtenä kappaleena: mitä tutkittiin ja miten sekä mitkä olivat tärkeimmät tulokset. Suomenkielisen opinnäytteen tiivistelmä kirjoitetaan suomeksi ja englanniksi ja ruotsinkielisen vastaavasti ruotsiksi ja englanniksi. Suomen- tai ruotsinkielisten opiskelijoiden, joiden opinnäytteen kieli on englanti, tulee kirjoittaa tiivistelmänsä englanniksi ja koulusivistyskielellään. Muiden kuin koulusivistyskieleltään suomen- tai ruotsinkielisten tulee kirjoittaa tiivistelmänsä vain englanniksi. Opiskelija voi halutessaan lisätä opinnäytteeseensä toisen tai kolmannen tiivistelmän omalla äidinkielellään. Tämän opinnäytteen tiivistelmäteksti kirjoitetaan opinnäytteen luettavan osan lomakkeen lisäksi myös pdf-tiedoston metadataan. Kirjoita tähän metadataan kirjoitettavaa teksti. Metadatatextissa ei saa olla erikoismerkkejä, rivinvaiho- tai kappaleenjako-merkkiä, joten näitä merkkejä ei saa käyttää tässä. Jos tiivistelmäsi ei sisällä erikoismerkkejä eikä kaipaa kappaleenjako-merkkiä, voit hyödyntää makroa `abstracttext` luodessasi lomakkeen tiivistelmää (katso kommentti tässä TeX-tiedostossa alla). Metadatatiiivistelmäteksin on muuten oltava sama kuin lomakkeessa oleva teksti.

---

**Avainsanat** Vastus, resistanssi, lämpötila

---

---

**Författare** Eddie Engineer

---

**Titel** Arbetets titel — Arbetets möjliga underrubrik

---

**Doktorandprogrammet i** Elektronik och electroteknik

---

**Ansvarsprofessor och handledare** Prof. Pirjo Professori

---

**Samarbetspartner** Fyll i det här fältet om du skrev ditt arbete för ett företag

---

**Datum** 30.9.2025

---

**Sidantal** 24+15

---

**Språk** engelska

---

### **Sammandrag**

Sammandraget är en kort beskrivning av arbetets centrala innehåll: vad undersöktes, hur undersöktes det och vilka var de viktigaste resultaten?

I lärdomsprov som skrivs på svenska skrivs sammandraget på svenska och engelska, på motsvarande sätt skrivs sammandraget på finska och engelska i lärdomsprov på finska. Finsk- eller svenskspråkiga studerande som skriver sitt lärdomsprov på engelska ska skriva sammandraget på engelska och på sitt skolutbildningsspråk. Studerande vars skolutbildningsspråk inte är svenska eller finska skriver sammandraget endast på engelska. Den studerande kan om hen så önskar lägga till ett andra eller tredje sammandrag på sitt eget modersmål. Sammandraget fungerar då ofta som mognadsprov och bör i så fall vara minst 300 ord långt. Information om mognadsprov på svenska finns på MyCourses:

<https://mycourses.aalto.fi/course/view.php?id=26872>.

---

**Nyckelord** Nyckelord på svenska, temperatur

---

## **Preface**

I want to thank Professor Pirjo Professor and my instructors Dr Alan Advisor and Ms Elsa Expert for their guidance.

I also want to thank my partner for keeping me sane and alive.

Otaniemi, 30 September 2025

Eddie E. Engineer

# Contents

<b>Abstract</b>	<b>3</b>
<b>Abstract (in Finnish)</b>	<b>4</b>
<b>Abstract (in Swedish)</b>	<b>5</b>
<b>Preface</b>	<b>6</b>
<b>Contents</b>	<b>7</b>
<b>Symbols and abbreviations</b>	<b>8</b>
<b>1 Introduction</b>	<b>9</b>
1.1 Typical content in the introduction . . . . .	9
<b>2 Literature review</b>	<b>10</b>
2.1 Structure of the thesis . . . . .	10
2.2 Page numbering . . . . .	11
2.3 Structuring the text in the main matter . . . . .	11
2.3.1 Sections . . . . .	11
2.3.2 Paragraphs . . . . .	12
2.3.3 Equations . . . . .	12
2.3.4 Figures and tables . . . . .	13
2.4 Referencing parts in the thesis . . . . .	14
2.5 Citation . . . . .	15
2.5.1 Bibliography or list of references . . . . .	15
<b>3 Research material and methods</b>	<b>19</b>
<b>4 Results</b>	<b>20</b>
<b>5 Summary/Conclusions</b>	<b>21</b>
<b>References</b>	<b>22</b>
<b>A Contents of an appendix</b>	<b>25</b>
<b>B Page layout and typographical design</b>	<b>26</b>
<b>C Reference and in-text citation guidelines</b>	<b>29</b>

## Symbols and abbreviations

### Symbols

<b>B</b>	magnetic flux density
$c$	speed of light in vacuum $\approx 3 \times 10^8$ [m/s]
$\omega_D$	Debye frequency
$\omega_{\text{latt}}$	average phonon frequency of lattice
$\uparrow$	electron spin direction up
$\downarrow$	electron spin direction down

### Operators

$\nabla \times \mathbf{A}$	curl of vector $\mathbf{A}$
$\frac{d}{dt}$	derivative with respect to variable $t$
$\frac{\partial}{\partial t}$	partial derivative with respect to variable $t$
$\sum_i$	sum over index $i$
$\mathbf{A} \cdot \mathbf{B}$	dot product of vectors $\mathbf{A}$ and $\mathbf{B}$

### Abbreviations

AC	alternating current
APLAC	an object-oriented analog circuit simulator and design tool (originally Analysis Program for Linear Active Circuits)
BCS	Bardeen-Cooper-Schrieffer
DC	direct current
TEM	transverse electromagnetic

# 1 Introduction

This is the template file for writing your bachelor's, master's or licentiate thesis. The template contains parts and text to accommodate the different degree levels, bachelor's and master's, and so it may contain parts that may not be relevant to your thesis. If so, simply delete those parts in the thesis that you do not need. This applies particularly to the abstract pages, the list of symbols, the list of abbreviations, and appendices. You may also want to adjust the template section titles to better suit your work.

The text and comments in this template advise you how to use the template, give general pointers on how to write your thesis (you must still refer to writing guides and converse with your advisor and/or supervisor in this regard), and provide the technical specifications for the layout and style of the template.

## 1.1 Typical content in the introduction

In principle, the introduction is like the abstract, only broader in scope, and more detailed. The introduction generally describes the following:

- a description of the background of the field of study, what similar work others have already done, as well as an overview of the study,
- the goals of the study,
- the primary research question and the sub-problems in the line of inquiry, and
- the scope and constraints of the study along with the main concepts involved.

Although the introduction is a general description of the study, be concise and avoid writing a lengthy introduction. A concise introduction need not have any subsections.

## 2 Literature review

### 2.1 Structure of the thesis

The thesis comprises the front matter, the main matter and possible appendices. The front matter in the required order is:

- a cover page,
- a page containing copyright information,
- the abstract page(s),
- an optional preface, and
- a table of contents.

If the thesis contains mathematical equations, give the list of symbols used to represent various quantities along with the mathematical operators used. The list must contain all the abbreviations used as well. Note that lists of figures and tables are not required.

The main matter, i.e. the actual thesis, begins after the list of symbols and abbreviations. Its structure follows the standard structure used in scientific writing. A typical division of the content is

1. Introduction (research objectives and questions)
2. Literature review (research made earlier in this area)
3. Research material and methods
4. Results / Findings
5. Discussion
6. Summary / Conclusions
7. References

The parts 1–6 in the list above are the text of your thesis. Often the discussion and summary (or conclusions) are combined in one chapter. The wording of the titles suggested above may differ. As a matter of fact, the titles above refer more to the type of content rather than being title suggestions. For example, the literature review of a thesis on electromagnetics could be under the title ‘Electromagnetic theory and FDTD’. The background to the methodology used—FDTD here—could also be in this chapter. Note that the chapters and sections within the main matter are numbered, and that they appear in the table of contents. The references, or the bibliography, is also shown in the table of contents, but without a number labelling it.

The appendix or appendices, when necessary, are presented in the last part of the thesis. They contain things like questionnaires used in the study, [selected parts of]

data, derivations of mathematical results, a more detailed exposition of some aspect in the thesis, or code listings. Number them in the table of contents as follows:

- A. The first appendix
- B. The second appendix

Refer to a suitable guide on writing a thesis for a comprehensive description; there are plenty of them around. The instructions here are not exhaustive, and they concentrate more on how to use this template.

A bachelor's thesis is ideally about 20 pages long, excluding the appendices, whereas a master's thesis is about 60 pages long, again, not counting the pages in the appendices. The numbers pertaining to the length of your thesis given here are mere rules of thumb. Consult your school's thesis guidelines and your thesis advisor and/or supervisor for the appropriate length in your case.

## 2.2 Page numbering

Number the pages using Arabic numerals, placed in the centre of the page footer. The numbering begins from the cover page and runs continuously to the end of the thesis. Enter the total number of pages in the thesis—front matter, main matter and appendices, if present—in the appropriate field on the abstract page. Enter also the number of pages in the appendices, if present, in the same field on the abstract page as follows: total number of thesis pages / number of pages in the appendices.

Do not print the page numbers on the cover and the copyright pages; number all the other pages. Thus, the first page with a page number printed on it—the first abstract page—is '3'. The page numbering of appendices continues from that on the previous page.

## 2.3 Structuring the text in the main matter

### 2.3.1 Sections

You can structure your text by dividing it into sections with a suitable title. Well-devised sectioning clarifies your text, but beware of overusing them, since that will fragment and confuse your text. Do not use more than three levels of hierarchy in your sections. Notice that the section titles, just as the figure and table labels, are in a Helvetica clone, a sans serif, or grotesque, font. The main matter text is typeset in a Times clone, a serif font.

The sectioning macros available in  $\text{\LaTeX}$  are

```
\section{title},  
\subsection{subtitle}, and  
\subsubsection{subsubtitle}.
```

The formatting specifications are in appendix B. The fonts specified there are for Word documents, as specified by Aalto’s visual guidelines. No corresponding fonts are officially specified for L<sup>A</sup>T<sub>E</sub>X. Hence, similar corresponding fonts provided by the `newtxtext` package are used in this template. Math fonts are those from `newtxmath`. The most important factor that influenced this choice of fonts was that the package outputs PDF/A-1b compliant pdf using `pdflatex`.

At least in technical texts, refraining from using the articles ‘a’ and ‘the’ as the first word in the title is common practice. Appendices are enumerated using capital letters. Begin every section on a new page. Begin a subsection on a new page only if the previous page is full. Similarly, begin every appendix on a new page.

### 2.3.2 Paragraphs

The paragraph that follows the section title is not indented, the paragraphs that follow are. Often, the body text is typeset as `raggedright` to avoid unnecessarily large white spaces between words. On the other hand, in many technical fields, the text is justified on both sides, but in such cases, hyphenation is used to maintain reasonable separation between words. This template uses justified text with automatic hyphenation. Write paragraphs so that they span more than three lines. Rethink your text, if you end up having one-line paragraphs; avoid them in your thesis—including the appendices. In addition, you may need to reconstruct your text if your paragraphs are too long. Avoid emphasising text using italics. Italicised text makes reading for dyslexic readers even more difficult.

When a number has a unit associated with it, ensure two things: the space between the number and the unit is smaller than the regular space (for example, 1 Hz) and the number and unit are not split over lines. You can simply use `\,` between the number and the unit without spaces between them to stop them from being split (`1\,Hz`) or use the package `siunitx`.

### 2.3.3 Equations

Equations are numbered using Arabic numerals, typically enclosed in parentheses, but not always. This template encloses equation numbers in parentheses. An example equation is

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left( a_n \cos \frac{n\pi x}{L} + b_n \sin \frac{n\pi x}{L} \right). \quad (1)$$

Closely related equations like equations in a system of equations may be numbered as follows:

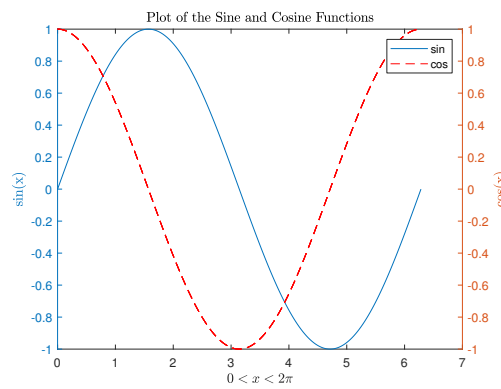
$$V_s = R_s i_s + R(i_s + i_b) \quad (2a)$$

$$V_b = R_b i_b + R(i_b + i_s). \quad (2b)$$

All equations need not be numbered. Remember punctuation after the equation; an equation is an integral part of your sentence and may need to be followed by punctuation marks. Many scientific journals do not use them after equations; then



**Figure 1:** A coil terminated in two LEDs with a magnet placed at its centre!!



**Figure 2:** Example of a MATLAB graph.

again, many do. Punctuate the equations in your thesis. Numbering of equations in appendices consists of the appendix numbering alphabet followed by the equation number, which starts from one in each appendix. For example, the first equation in appendix A would be equation (A1) and the first two equations (A1)–(A2).

### 2.3.4 Figures and tables

Theses generally contain figures and tables, which have captions describing them. For figures, the convention is to place the caption after (below) the figure, as shown in figure 1 and figure 2. Tables, on the other hand, have the caption above (before), as evident from table 1. The label and number are typeset in the sans serif bold 12-pt typeface and the caption in the serif 12-pt normal typeface (see appendix B).

**Table 1:** An example table. Common animals classified into their classes.

<b>Mammals</b>	<b>Birds</b>	<b>Insects</b>
dog	crow	ladybird
cat	sparrow	ant
rat	tit	cockroach

Avoid placing figures and tables such that they are preceded or followed by just a line or two, because the reader can have difficulties in finding the line(s) of text and might even accidentally miss the text completely. Consider, for example, a page beginning with one line of text continued from the preceding page and that ends the paragraph. This is followed by a figure, then a short three-line paragraph, then yet another figure, followed by more text, which is positioned such that only two lines of text are on the page and the remainder is placed on the following page. The layout of this page is fragmented, and as a result, the reader might initially miss the top line of text. Consider using one of the following three layout possibilities: place the figures in the top part of the page followed by the text, or place the text in the top followed by the figures, or place all the text in the middle with one figure on the top and the other at the bottom. Base your choice on considering how easily the reader can follow your text (the content of the figures affects this), and whether the page as a whole looks ordered and pleasing to the eye.

Strive to place the referenced figure or table on the same page as where it is referenced. If this is difficult, place it on the following page, but not very much further. Using the options `b` (for bottom), `t` (for top), `h` (for here) and `p` (for separate page) judiciously in the `figure` and `table` environments,  $\text{\LaTeX}$  does a pretty good job of placing figures and tables. However, placing figures (and tables) close to where they are referred to may be impossible when you have many pictures, so use common sense and keep the reader in mind when placing pictures and tables.

## 2.4 Referencing parts in the thesis

Cross-referencing in  $\text{\LaTeX}$  is simple and straightforward: use `\label{marker}` to label the object with a number and then refer to the object using `\ref{marker}`. `marker` should be a unique string of characters. To help keep you organised with the various reference labels, be systematic when creating them for different objects in the thesis. For example, start labels for figures with `fig:`, for tables with `tab:`, `sec:` for sections, and `eq:` for equations, as done in this template. So, you could have, say, `\label{sec:ohmslaw}`, `\label{eq:ohmslaw}`, `\label{fig:ohmslaw}`, and `\label{tab:ohmslaw}`.

Perhaps you will have noticed that when referencing objects in the text, as is done for ‘figure’ earlier in the text, the label ‘figure’ in the cross-reference is not capitalised. Often, you see the capitalised label ‘Figure’. In such cases, the label together with the number, for example ‘Figure 2’, is considered a proper noun, hence the capitalisation. Although this template uses the lowercase form, you can choose how you write cross-referencing labels: ‘figure’ or ‘Figure’—you will do well to consult your advisor and supervisor about this; they may have strong opinions on the matter. However you decide to write cross-referencing labels—figure, table, section or equation—be consistent.

Do not abbreviate any of the labels, for example ‘figure’ to ‘fig.’ or ‘Fig.’. Journals do this because the amount of available space for an article is limited; space is not an issue in your thesis. You can refer to more than one figure, for example, by saying figures 1 and 2. Use endash ‘--’ to specify a range: sections 1–5.

To reference a section, place the section label directly after the sectioning command of the section to be referenced. For example:

```
\subsection{Ohm's law}
\label{sec:ohmslaw}
...
...as discussed in section~\ref{sec:ohmslaw}, the resistance...
```

The tilde placed between ‘section’ and ‘\ref{sec:ohmslaw}’ not only puts a normal space between the two, but also binds them so that they are not split over separate lines if the two occur at the end of a line. Put a tilde between all labels and the reference number.

For figures and tables, place the label text after \caption. For simple equations, the label is placed after \begin{equation}. You can reference individual items such as equation (2a) in a grouped equation environment like subequations or an item in an itemised list like item 1 on page 10 or the system of equations (2) by putting a \label appropriately.

## 2.5 Citation

The list of reference must be carefully made, following one of many different styles. Which you choose depends on the field of your thesis. However, citing using footnotes is not allowed in your thesis<sup>1</sup>. A short reference list can have entries in the order in which they are cited, but if your list is long, arrange the entries in alphabetical order. Read appendix C for a fairly thorough discussion of how to cite work in academic writing and make a bibliography or list of references. Remember that referencing is a very important part of your thesis, so be meticulous and thorough.

### 2.5.1 Bibliography or list of references

Find here a list of some of the typical entries in the bibliography and the information they must contain. For a more comprehensive list, see [3]. See appendix C for details on how this information must be typeset in different reference styles.

A book entry must contain the following:

- author(s)
- title of the book
- edition, if there are more than one
- publisher
- place of publication
- time of publication (typically year)
- name of series, if the book is part of a series

---

<sup>1</sup> Adding comments in footnotes is not allowed either.

References [14]–[16] are examples of books in the bibliography. Referring to a particular place in a book, for example like this, [16, s. 83–124], is a good practice. The reader can thus find the referred matter easily.

The following must be found in an article entry:

- author(s)
- title of the article
- name of the journal or magazine where the article is published
- volume number of the journal or magazine
- issue number of the journal or magazine
- year of publication
- page numbers of the published article

References [11]–[12] are examples of articles in a bibliography.

An edited book or compilation of contributions, typically chapters or articles, from several authors having one or more editors or a compiled conference proceedings must have the following information:

- author(s) of the chapter or part
- title of the chapter or part
- mention the kind of publication ‘In book’, or for conference proceedings with no editor information use ‘In’ before the name of the conference proceedings
- editor(s) of the compilation identified with (Ed.) or (Eds.)
- name of the compiled book or conference
- for a conference article, the time and place where the conference was held
- edition, if more than one
- place of publication
- publisher (may not exist for conference proceedings)
- time (year) of publication
- pages of cited contribution
- name of series, if the book is part of one

References [25]–[17] are examples of references to a part of a compilation.

Theses must have the following information:

- author
- title of the thesis
- type of thesis (bachelor’s, master’s doctoral, other)
- name of university or institution
- name of the department, faculty or degree programme
- location/place of the university or institution

- year of publication

References [20]–[19] are examples of theses in a bibliography.

Standards must have the following:

- standard identifier and number
- name of the standard
- edition, if not the first
- place of publication
- publisher
- year of publication
- number of pages

Reference [24] is an example of how a standard is entered in a bibliography.

An interview entry must have the following details:

- name of the interviewee
- position or t academic and/or professional title
- organisation where the interviewee is placed
- address of the organisation
- a mention that the entry is an interview along with the date of the interview

Reference [21] is an example of an interview entry in a bibliography.

Most scientific articles are available online nowadays and many also in printed form. Articles from journals, magazines or other publications available only online must have the following details in the bibliography:

- author(s)
- name of the article
- name of the publication (journal or magazine)
- type of publication
- edition or volume
- volume number and issue details of publication and article
- year of publication along with details on possible updates: Updated, date of update
- mention ‘Accessed’ and date when accessed
- mention ‘Available’ and URL or mention ‘DOI’ ja DOI number (DOI=Digital Object Identifier).

References [23]–[22] are examples of how theses available online are presented in a reference list. Additionally, references [23] and [26] available both online as well as in print, so the details are presented as for the corresponding entry in print and the details of the online version are also given. Reference [22] is available only online, so

only those relevant required details are given. Unfortunately, the details on the edition, publication name and number are often unavailable and so cannot be presented in the reference list.

For a thesis that is only available online, give the following details:

- author
- thesis title
- type of medium (online, DVD, CD-ROM etc.)
- type of thesis (bachelor's, master's doctoral, other)
- name of institution or university
- name of the department, faculty or degree programme
- location/place of the university or institution
- year of publication
- date of citation
- availability: mention 'Available' and give the URL and/or mention 'DOI' and the DOI number

Reference [10] is an example of how a thesis available in electronic form is entered in a bibliography.

Reference [15] is an example of an online stand-alone article, one not associated with any journal or magazine. Such an article is considered a work of its own. The details required of such a stand-alone webpage are:

- author(s)
- title
- mention 'Updated' and date of update
- mention 'Accessed' and date of access
- mention 'Available' and the URL

If the article spans more than one page, the reference list must contain the URL of the page pointing to the entire article, typically its homepage, unless the intention is to cite a particular page in the article.

### **3 Research material and methods**

This part is the core of your work, where you explain the methodological choices you made, its limitations, how you pick your research material or subjects, the implementation of your study and the methods used. This section determines the methodological strengths and weaknesses of your thesis. Any earlier description of the method should limit itself to work done earlier by others. Here you tell your reader what you have done.

## **4 Results**

Present the results of your study here and answer the research questions, asked earlier in the thesis (in the introduction, perhaps), this study strives to answer. The scientific value of your work is measured by the results you obtain along with the arguments you give to back the answers to your research questions.

Be critical of the significance of your results. You may critically scrutinise the results and your interpretation of the results here, or you may do so later in the chapter with the discussion of your work or in the conclusions part.

This part should discuss how reliable the data used in the study are. You may discuss the reliability of the conclusions drawn from the study either in this chapter or later in the discussions part. You may have the discussion in a chapter of its own, separate from the summary or conclusions.

## **5 Summary/Conclusions**

This is where you tie up any loose ends. Tell your reader briefly and clearly what you have done, what you have discovered, and the value of your discovery in the context of similar work done earlier. Draw clear conclusions regarding the research problem, sub-problems or hypotheses. You also discuss future lines of study and new questions your study might have posed.

As the author of the thesis, you alone are responsible for ensuring that the layout, form and structure of your thesis adheres to the guidelines outlined by your school. This template aims to help you meet these requirements.

## References

This is the list of references to the sources cited in appendix B. The list more or less follows the Vancouver style (IEEE). See appendix C for a detailed exposition on cross-referencing and bibliography styles. Follow the description there.

The references are in alphabetical order here, which is the typical way to organise the reference list. For a short reference list, the other approach is to put the references in the order of citation.

- [1] Bailey, C., *The Basics of Typography*. [Online]. <https://www.webfx.com/blog/web-design/the-basics-of-typography> (accessed on 14 July 2021).
- [2] Bringhurst, R., *Horizontal Motion. The Elements of Typographic Style*, Point Roberts, WA: Hartley & Marks, 1992. p. 26, pp. 25–36. Also available online as version 3.0 at <https://smallpressblog.files.wordpress.com/2017/11/bringhurstelementsselections1.pdf> (accessed on 7 May 2021).
- [3] Citation Guide: Making a bibliography, *Aalto University Learning Centre*. Online article. Available <https://libguides.aalto.fi/c.php?g=410674&p=2797572> (accessed on 14.7.2021)
- [4] de Buen Unna, J., *Manual de diseño editorial*, 4. ed. corregida y aumentada, Somonte-Cenero, Gijón: Ediciones Trea, 2014.
- [5] Dyson, M. C., and Kipping, G. J., “The Effects of Line Length and Method of Movement on Patterns of Reading from Screen,” *Visible Language*, vol. 2, no. 2, pp. 150–181, 1998.
- [6] Shaikh, A. D., “The Effects of Line Length on Reading Online News,” *Usability News*, vol. 7, no. 2, July 2005.
- [7] “Visual elements,” *Aalto University Brand Library*. [Online]. <https://www.aalto.fi/en/brand-library#/visual-elements/typography> (accessed 14 July 2021)
- [8] Wikipedia contributors, “Line length,” *Wikipedia: The Free Encyclopedia*, Wikimedia Foundation, Inc., 22 July 2004. [https://en.wikipedia.org/w/index.php?title=Line\\_length&oldid=997524503](https://en.wikipedia.org/w/index.php?title=Line_length&oldid=997524503) (accessed 7 May 2021).
- [9] Wikipedia contributors, “Leading,” *Wikipedia, The Free Encyclopedia*, 2021. <https://en.wikipedia.org/w/index.php?title=Leading&oldid=1026690618> (accessed 14 July 2021).

The reference list that follows are examples containing the required information about the cited sources, and it more or less abides to the Vancouver style (IEEE). See appendix C for guidelines for making your reference list correctly.

- [10] Adida, B., *Advances in Cryptographic Voting Systems*, PhD Thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts, 2006. Online document. Accessed 19.1.2007. Available: <http://crypto.csail.mit.edu/~cis/theses/adida-phd.pdf>.
- [11] Bardeen, J., Cooper, L. N. ja Schrieffer, J. R., “Theory of Superconductivity,” *Physical Review*, 1957, vol. 108, no. 5, pp. 1175–1204.
- [12] Deschamps, G. A., “Electromagnetics and Differential Forms,” *Proceedings of the IEEE*, 1981, vol. 69, no. 6, pp. 676–696.
- [13] Itkonen, M., *Typografian käsikirja*, 3rd edition, Helsinki, RPS-yhtiöt, 2007.
- [14] Kauranen, I., Mustakallio, M. and Palmgren, V., *Tutkimusraportin kirjoittamisen opas opinnäytetyön tekijöille*, Espoo, Teknillinen korkeakoulu, 2006.
- [15] Kilpeläinen, P., WWW-lähteisiin viittaaminen tutkielmatekstissä. Online article. Updated 26.11.2001. Accessed: <http://www.cs.uku.fi/~kilpelai/wwwlahteet.html>.
- [16] Koblitz, N., *A Course in Number Theory and Cryptography. Graduate Texts in Mathematics 114*, 2nd edition, New York, Springer, 1994.
- [17] Lindblom-Yläne, S. and Wager, M., “Tieteellisten opinnäytetöiden ohjaaminen,” in: Lindblom-Yläne, S. and Nevgi, A. (Eds.), *Yliopisto- ja korkeakouluopettajan käsikirja*, Helsinki, WSOY, 2004, pp. 314–325.
- [18] Loh, N. C., *High-Resolution Micromachined Interferometric Accelerometer*, Master’s thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts, 1992.
- [19] Lönnqvist, A., *Applications of hologram-based compact range: antenna radiation pattern, radar cross section, and absorber reflectivity measurements*, Doctoral thesis, Teknillinen korkeakoulu, Department of Electrical and Telecommunications Engineering, 2006.
- [20] Miinusmaa, H., *Neliskulmaisen reiän poraamisesta kolmikulmaisella poralla*, Master’s thesis, Teknillinen korkeakoulu, Department of Mechanical Engineering, Espoo, 1977.
- [21] Palmgren, V., Planning Officer, Teknillinen korkeakoulu, library, Otaniementie 9, 02150 Espoo. Interview, 15.1.2007.
- [22] Pohjois-Koivisto, T., “Voiko kone tulevaisuudessa arvata tahtosi?,” *Apropos*. Online publication, February, no. 1, 2005. Accessed 19.1.2007. Available: <http://www.apropos.fi/1-2005/prima.php>.

- [23] Ribeiro, C. B., Ollila, E. and Koivunen, V., “Stochastic Maximum-Likelihood Method for MIMO Propagation Parameter Estimation,” *IEEE Transactions on Signal Processing*, vol. 55, no. 1, pp. 46–55. [Online]. Accessed 19.1.2007. Also available in print. DOI: 10.1109/TSP.2006.882057.
- [24] SFS 5342, *Kirjallisuusviitteiden laatiminen*, 2nd edition, Helsinki, Suomen standardisoimisliitto, 2004. 20 p.
- [25] Sihvola, A. et al., “Interpretation of measurements of helix and bihelix superchiral structures,” in: Jacob, A. F. and Reinert, J. (Eds.) *Bianisotropics '98 7th International Conference on Complex Media*, Braunschweig, 3.–6.6.1998, Braunschweig, Technische Universität Braunschweig, 1998, pp. 317–320.
- [26] Stieber, T., “GnuPG Hacks,” *Linux Journal*. Online publication, 2006, November, no. 143. Accessed 19.1.2007. Also available in print. Available: <http://www.linuxjournal.com/article/8732>.

## A Contents of an appendix

Appendices are not essential in a thesis, and so you must plan the content of your thesis as if it does not contain an appendix. The appendix cannot be used as a dumping ground for text and ideas from an overgrown thesis.

An appendix is an independent entity, even though it complements the thesis. So, the appendix is not, say, just a list or image or table, but contains explanatory text as well that indicates the purpose of its content. It can contain code listings, like the one below for a simplified list of commands to create an appendix.

```
\clearpage
\appendix
\addcontentsline{toc}{section}{Contents of an appendix}
\thispagestyle{empty}
\section*{Contents of an appendix}
...
text
```

Equation numbering in the appendix forms a separate, complete entity. Here are a couple of examples how equations in an appendix are numbered:

$$(x + a)^n = \sum_{k=0}^n \binom{n}{k} x^k a^{n-k}, \quad (\text{A1})$$

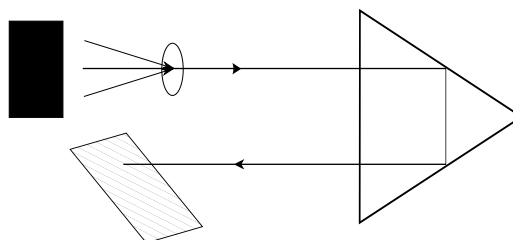
$$\sin \alpha \pm \sin \beta = 2 \sin \left( \frac{\alpha \pm \beta}{2} \right) \sin \left( \frac{\alpha \mp \beta}{2} \right). \quad (\text{A2})$$

The appendix can contain figures that do not fit in to complement the text in the thesis. The numbering of figures is like that of equations: see figure A1.

The numbering of tables is like that for equations and figures, as is evident from the caption of table A1.

**Table A1:** Caption for the table.

9.00–9.55	Safety instructions on the use of laboratories
9.55–10.00	Transfer to the laboratory



**Figure A1:** Figure and caption to show the numbering in the appendix.

## B Page layout and typographical design

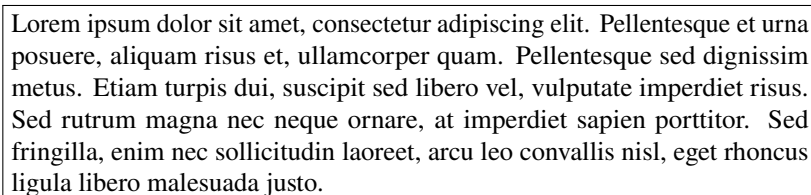
### Layout choices

Designing a visually pleasing, balanced and easily readable document requires setting several typographic parameters, one of the most important ones being the line length. If too wide, the reader's eyes have trouble focusing on the text because the line length makes it difficult to gauge when the line begins and where it ends; too narrow, and the reader's eyes have to travel back too often, breaking their reading rhythm and often causing them to begin the next line before finishing the current one.

Traditional research on the effect of line length on readability of printed text have found that 45–75 characters per line (cpl) is an acceptable range, with 66 cpl being the ideal [2, 8]. This number includes letters, numbers and spaces. The line length in conventional books tends to be 30 times the type size, but anything between 20 and 40 times is considered acceptable. For example, for a 10-pt font, an acceptable line length is 300 points (30×10), or about 10,58 cm. The reader's experience as a reader also affects the preferred line length; an experienced reader can handle between 45 and 80 cpl for a comfortable reading experience, whereas a novice prefers a line length of between 34 and 60 cpl [4].

Reading text from a screen poses challenges absent in paper: glare, flicker and scrolling. Research seems to indicate that longer lines are better for scanning through the text whereas shorter lines are preferred for accurate reading. One study says that reading speed at a certain level of comprehension seems to be better for longer lines (100 cpl) than for shorter lines (25 cpl) [5]. Another study [6] indicates that subjective preferences for longer or shorter line lengths appear to be contradictory. About 60% of the test subjects preferred the presented shortest (35 cpl) or longest (95 cpl) lines, and at the same time all of them disliked either the shortest or the longest lines. (See also [8].)

Another important typographical parameter is line leading or leading, which refers to the distance between adjacent lines of text. Double spacing is a practice from the era of typewriters particularly in academia to allow making handwritten comments in documents. Typewriters had a limited number of options for leading, and double spacing was chosen as a norm. Too much leading can cause continuity problems, since the reader's eyes must travel a greater distance between lines of text. The amount of leading is a compromise between ease of reading, desired efficiency in the use of



Lorem ipsum dolor sit amet, consectetur adipiscing elit. Pellentesque et urna posuere, aliquam risus et, ullamcorper quam. Pellentesque sed dignissim metus. Etiam turpis dui, suscipit sed libero vel, vulputate imperdiet risus. Sed rutrum magna nec neque ornare, at imperdiet sapien porttitor. Sed fringilla, enim nec sollicitudin laoreet, arcu leo convallis nisl, eget rhoncus ligula libero malesuada justo.

**Figure B1:** Text typeset in a 300-pt-wide box using a font size of 10 pt. The resulting average number of characters per line is about 60. The text is framed to make the box size evident.

vertical space, weight and type (serif or sans serif) of the typeface used, and visual aesthetics. Naturally, whether a document is printed or published online affects the leading, but even the language of the text must be considered when deciding on the required leading. (See also [9].)

## Aalto University's visual guideline for writing documents

Of Aalto University's visual guidelines [7], the one that applies to document writing is related to the use of fonts. This guideline specifies that the body of the text be in the serif font Sentinel and the section titles in boldface of the sans serif font Nimbus Sans. These fonts should be available on all Aalto computers. However, being a commercial product, Sentinel can be replaced with Georgia and Nimbus Sans with Arial, both of which come installed in all Windows machines. Thus, Georgia and Arial are the fonts used in the Word template. The font choices for this L<sup>A</sup>T<sub>E</sub>X template are a Times and Helvetica clone from the `newtxtext` package since it provides support for math fonts and its output is a PDF/A compliant pdf.

## Layout and typographical specifications

### Page layout in the thesis

The thesis is typeset on A4-sized paper. The text width is set to an average of about 75 cpl as a compromise between having to read the thesis on a computer screen and on paper, as discussed above. For the font size of 12 pt to be used in the body text, the text width works out to 14,2 cm. For the online version of the document, the text column is centred, implying that the left and right margins are both 3,4 cm. If you want to print the document and bind it, the binding margin must be 4,8 cm. The text height is set to 23 cm by setting the top margin to 3,7 cm and the bottom margin to 3 cm. The layout dimensions are summarised in table B1.

**Table B1:** Page layout dimensions.

Paper size	A4
Text width	14,2 cm
Top margin	3,7 cm
Bottom margin	3,0 cm
<b>Online document</b>	
Left margin	3,4 cm
Right margin	3,4 cm
<b>Printed document (for binding)</b>	
Left margin	4,8 cm
Right margin	2,0 cm

### **Sectioning and text body**

The font for the body text is a 12-pt serif Times clone and a Helvetica bold clone for the section titles. Use at most three levels of hierarchy in your text: section, subsection and subsubsection. The lower section numbering must use the section number of the higher section. For example, section number 2.1.3 refers to section 2, subsection 1 and subsubsection 3.

## C Reference and in-text citation guidelines

With regard to standard practice across academic disciplines, it is important to use an in-text citation to indicate when your work borrows or refers to words or ideas from a specific source. A full reference of this source should be included in your 'References' / 'Bibliography' / 'Works Cited' section as well.

There are two major referencing styles: the Harvard style and the Vancouver style. The former was first introduced in a journal article by Professor of Zoology Edward Marks in 1881 during his tenure at Harvard University (Chernin, 1988, 1062). It has since become an umbrella term to refer to styles which utilise author-date (e.g., APA style) or author-page (e.g., MLA style) within parentheses (). It still remains in use to some degree in the natural sciences (e.g., American Chemical Society, 2006) and has become the predominant style within the social sciences (e.g., American Psychological Association, 2010), and the arts and humanities (e.g., Modern Languages Association, 2016; University of Chicago Press, 2017). In contrast, the latter Vancouver style has become a very common style within the fields of engineering, technology and science. The name is derived from the inaugural meeting in Vancouver, Canada in 1978 of a committee later referred to as the International Committee of Medical Journal Editors (ICMJE) (BMA, 2012). The style is typified by its use of numbers for in-text citations; as such, it is also known as the author-number system. One of the most common versions of the Vancouver Style is the IEEE Reference Guide (IEEE 2018). The numbers used for in-text citations correspond to a numbered reference list at the end of the text. Typically, the numbers refer to the order in which the referenced authors first appear in the text. Thereafter, they continue to be referred to by this number. A lesser utilised variation of this style can feature the numbers corresponding to an alphabetical list of authors.

There is a third system of notes and bibliography. This is one of the two styles in the Chicago Manual of Style; the other is an author-date style. Notes and bibliography is mostly used by the fields of literature and history. It is occasionally utilised in the field of arts, but it is considerably less common than the Harvard style. Among the 97 English doctoral dissertations available online in AaltoDoc as of 5 March 2020, only 14 utilised this method. As it is relatively rare within Aalto University, it is recommended to visit the Chicago Manual of Style online for the reference style guide for it.

The two key considerations in adopting a particular style are that you agree with your supervisor on the particular style at the start of your thesis writing process and that you remain consistent in the use of the style throughout your thesis. Your supervisor can provide recommendations for you on the common style guides generally used in your field.

Below, you will find general guidelines to these two major styles with reference to the specific style guides in use. Corresponding examples are provided in the boxes below. Please note that the use of boxes here is only to visually separate the examples for clarity's sake and that boxes should not be used when quoting or paraphrasing in your own thesis.

## Direct quotes

If you are using the exact wording from a source, you should place this in double quotation marks (“ ”) followed by the author, date, and page number in parentheses (if using the Harvard style) or a number in square brackets [if using the Vancouver style]. The citation should be on the same line and inside the punctuation. This citation should correspond to a full reference in the References / Bibliography / Works Cited section of your thesis. The punctuation used between the author, date, and page number may vary depending on which style guide you are using (compare, for example, The Chicago Manual of Style (University of Chicago Press, 2017), The Publication Manual of the American Psychological Association (APA, 2018), The MLA Handbook (MLA, 2016) and The New Oxford Style Manual (OUP, 2016)). However, it should be noted that the frequency of direct quote usage varies significantly between academic fields. While it is a fairly common practice to utilise quotes within art, design, architecture and business, it is rare in the science and engineering fields. Therefore, it is recommended that you ask your supervisor or check well-known journals in your field to gauge the frequency of quoting preferred by experts in your field.

## Quoting in Harvard style

**Example 1:** Quote, information-prominent, American Sociological Association (2019) style

Attending to these breakdowns not only result in an on-going re-constitution of relations between people and things but are also hotbeds for unleashing everyday “creativity, invention, imagination, and artfulness” (Jackson, 2014: 226).

*Source:* Durrani, M. 2018. Designers by any other name: exploring the sociomaterial practices of vernacular garment menders. *Design Research Society International Conference: Catalyst. DRS International Conference Series*. 4: 1731-1746. ISBN 978-1-912294-19-0 (electronic). DOI: 10.21606/dma.2018.495. © 2018 Design Research Society. This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License. <https://creativecommons.org/licenses/by-nc-sa/4.0/>.

**Example 2:** Quote, author-prominent, American Psychological Association (2010) style

Philosopher Mark Johnson (2007) argued that meanings emerge from “deeper explorations into the qualities, feelings, emotions, and bodily processes” (p. x).

*Source:* Aktaş, B. & Mäkelä, M. (2019). Negotiation between the maker and material: Observations on material interactions in felting studio. *International Journal of Design*, 13(2): 55–67. © 2019 Aktaş & Mäkelä. Copyright for this article is retained by the authors, with first publication rights granted to the *International Journal of Design*. All journal content, except where otherwise noted, is licensed under a Creative Commons Attribution-NonCommercial-NoDerivs 2.5 License.

## Block quoting

Block quotes are used for longer quotes. Note the line indentation on each line of the block quote below, starting from “There was . . .”, and the absence of quotation marks. Each style guide recommends its own minimum text length before using block quoting. [Compare: AMA - four lines of text or more; APA - 40 words or more; or Chicago - 100 words or more.]

### Example 3: Block quote, Harvard style, as recommended by journal

When the Center for Bits and Atoms won the National Science Foundation Grant in 2003, MIT engineers began to look for local communities around the world they could help via digital fabrication: “Instead of bringing information technology to the masses, the fab labs bring information technology development to the masses,” explained Gershenfeld, in the official press release (NSF 2004). Karlsen had a more colourful version:

There was an innovation competition launched by MIT globally to develop local projects. MIT sent some of its best teachers to Norway to find a suitable cooperation project. They found us through Telenor, who told them: ‘There is this crazy guy lost in the fjord who devised sensors for his animals.’ We enjoyed a great year of cooperation with MIT in 2001 and we were invited to Boston to present and develop this project.

*Source:* Kohtala, C & Bosqué, C. (2014). The Story of MIT-Fablab Norway: Community Embedding of Peer Production. *Journal of Peer Production*, 5 (8): 1–8. ISSN 2213-5316 (electronic). © 2014 public domain. <http://peerproduction.net/issues/issue-5-shared-machine-shops/peer-reviewed-articles/the-story-of-mit-fablab-norway-community-embedding-of-peer-production/>

## Paraphrasing

Paraphrasing is a more prevalent citation practice in many academic fields. In engineering and science, paraphrasing tends to dominate with quotations used only sparingly. In other fields, such as art and design, the ratio of quoting to paraphrasing varies significantly. Again, it is best to ask your supervisor or review journals from your field to see how common the practice is amongst your academic peers.

The intent behind paraphrasing is that you write the ideas or arguments of a source in your own words. This citation practice can allow for better integration of ideas, argumentation, and flow within the text. A good rule of thumb for paraphrasing is to have more than 80% of the paraphrased text in your own words. If you only change a few words from the original, you can run the risk of plagiarism, even if you cite the source. Words matter. If you use the exact combination of words from another author, these must be in quotes.

## Paraphrasing in Harvard style

**Example 4:** Paraphrase, author prominent, Chicago Manual of Style (2017) style

von Hippel (1986) suggested a four-step process for working with lead users: first identifying important trends and key customer needs, then identifying lead users and understanding their needs and possible solutions and finally working with lead users in order to improve or generate product/service concepts.

*Source:* Hyysalo, S., Kohtala, C., Helminen, P., Mäkinen, S., Miettinen, V., & Muurinen, L. (2014). Collaborative futuring with and by makers. *CoDesign*, 10(3–4), 209–228. DOI: 10.1080/15710882.2014.983937. © 2014 The Authors. *This is an Open Access article. Non-commercial reuse, distribution, and reproduction in any medium, provided the original work is properly attributed, cited, and is not altered, transformed, or built upon in any way, is permitted.*

**Example 5:** Paraphrase, information-prominent, Harvard style as recommended by journal

Obviously digital technologies will not destroy comics as we know them, but they may change their underlying decorum. In reality, these changes have continuously shaped the lives of the industry's amateurs and semi-professionals, who have to organize their time around a bricolage of fragmented schedules and poorly paid work (Woo 2015): from daily feeding a Patreon account while filling a scanlation request, to selling a print in Deviantart while reviewing the latest Doujinshi on a not-so-free-of-ads-blog are some of the patchwork tasks of the comics networked precariat in the age of semio-capitalism.

*Source:* Manouach, I. (2019). Peanuts minus Schulz: Distributed Labor as a Compositional Practice. *The Comics Grid: Journal of comics scholarship*, 9(16), 1–21. <https://doi.org/10.16995/cg.139> © 2019 The Author(s). *This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.*

## Paraphrasing in Vancouver style

**Example 6:** Paraphrase, information prominent, IEEE (2018) style

When a laser beam is scattered by a dielectric microparticle, resulting in light refraction on entering and leaving the particle, a small amount of momentum is transferred from the photons to the matter. This change in momentum, known as the gradient force, results in the attraction of the particle to the high intensity part of the beam (usually the centre). Optical trapping of microscale particles via this mechanism was first reported in the 1970s [1] and duly led to the initial observation of a single beam optical trap in 1986 [2]. These preliminary experiments, and many of the methodologies that developed from them, utilized the gradient force

exerted by a single, tightly focused Gaussian laser beam to trap particles in solution through what has become known as the “optical tweezer” effect. Since these initial findings, optical technology has evolved significantly, and traps that facilitate three dimensional manipulation of particles are now readily available. While originally limited to the controlled manipulation of individual particles, multitrap setups involving either splitting [3,4] or time sharing [5,6] with a single laser beam are now also commonly utilized. As a more advanced form of the former, holographic optical tweezers that employ diffractive optical elements such as spatial light modulators now allow computer controlled, independent manipulation of multiple particles [7–9]. A number of multitrap devices have also been developed based on the application of laser beams with more complex phase and intensity profiles, as for example Bessel or higher order Laguerre Gaussian beams [10–12].

*Source:* “Chirality in Optical Trapping and Optical Binding” by David S. Bradshaw, Kayn A. Forbes, Jamie M. Leeder, and David L. Andrews in *Photonics* 2015, available under a Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>) at <https://doi.org/10.3390/photonics2020483>.

If you would like to emphasise the inventor, you could rephrase the first in-text citation as “was first reported by Ashkin in 1970 [1]” or “was first reported by Ashkin [1]” if the year is less important. (Ashkin is the sole author of the paper. It was published in 1970.)

### **Tips for paraphrasing**

1. Identify the important points from the source text. Then, try to identify the relationship between these different parts. Is the relationship sequential, causal, contrasting, or conditional? Can these be replaced by synonyms? For example, the contrasting conjunction, but, can be replaced by however, although, nevertheless, yet or on the other hand. In many cases, these synonyms may require that you change the structure of the sentence, which in turn may help you to formulate the ideas in your own words.
2. Synonyms - A word such as give can be replaced with provide, supply or contribute. Refer to a thesaurus for more examples. You can find these online or at the Learning Centre. If you are unsure of how a new word might be used, check a dictionary or search the word in Google Scholar for examples of its use in context.
3. Common phrases - There are often multiple ways of expressing a given phrase in academic writing. For example, compare “Previous studies have not dealt with...” with “Researchers have not treated X in much detail” or “Most studies in the field of X have only focused on...” These examples were drawn from the University of Manchester’s (2018) Academic Phrasebank

(<http://www.phrasebank.manchester.ac.uk/>). This corpus of common phrases includes hundreds of examples, categorised according to their functions.

4. Additions or deletions - Can you add a missing item? Can you leave something out?
5. Change the structure of the sentence - There are many ways to change the structure. Can you change the sentence from passive voice to active voice, or vice versa? Can you rewrite the sentence with “It is” or “There is”? Can you switch to the inanimate agent, e.g. “This thesis discovered”? Refer to the Aalto University Language Centre site (<http://sana.aalto.fi/awe/>) in the “Cohesion” section for more ways to change the structure of a sentence.

#### **Example 7: Before and After Paraphrase**

##### **Before Paraphrase**

“Significant progress has been made in the use of smart textiles in wearable technology, especially in the sport and well-being sector. However, the medical sector still lacks commercial and viable solutions” (Ilen et al., 2019, p. 2).

##### **After Paraphrase**

While some industries have taken advantage of smart textiles in wearable technology, Ilen et al. (2019, p. 2) contend that the medical industry has yet to produce any viable products.

*Source:* Ilen, E., Groth, G., Ahola, M., & Niinimäki, K. (2019). *Empathy in a Technology Driven Design Process: Designing for Users without a Voice of their Own*. Paper presented at 8th biannual Nordic Design Research Conference: Nordes 2019: Who Cares?, Espoo, Finland. Open Access paper.

#### **Avoiding the pitfalls of the Finnish paragraph-length paraphrase (FPP)**

In Finland, there exists a method of citation that is not permitted or recognised by many international style guides, including IEEE Reference Guide (IEEE 2018); Information and documentation — Guidelines for bibliographic references and citations to information resources (ISO 690:2010(E)) (ISO 2010); New Oxford Style Manual (OUP 2012); Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers (CSE 2012); The Chicago Manual of Style (University of Chicago Press 2017); The Publication Manual of the APA (APA 2018). Due to this and the reasons discussed below, it is not recommended that this method be used when writing in English. Interestingly, the Finnish Standards Association (Suomen Standardisoimisliitto SFS ry) which emulates the ISO standard, does not recognise this either (FSA 2010). In the Finnish style of citation, writers can write an entire paragraph where every sentence comes from a single source. Then, at the bottom of the paragraph, they provide a citation in brackets outside the final punctuation (see example below). Generally, the Finnish method suggests that by putting the citation after the period, the citation then refers to all the sentences preceding it in the paragraph.

**Example 8:** Paraphrase, Finnish style, not recommended in English

Additive manufacturing was originally developed to guide product design by providing a way to create prototypes directly from digital designs. This method called rapid prototyping (RP), as the name implies, consumes less time and resources than most preceding techniques. For instance, the manufacturing of an injection mold for prototyping purposes would be extremely expensive. However, the part can be created with additive manufacturing for a fraction of the cost. Moreover, rapid prototyping is cost and time effective when it can substitute handcrafting, CNC manufacturing, or silicon molding. The downside when compared to these methods is often poor surface quality and inferior dimensional accuracy. However, RP enables fast iterative testing of products with a low threshold of prototypes failing expectations. This makes it a superior tool in product development and explains why prototyping has been the leading application of AM. (Wohlers 2013)

*Source:* Anonymous. (2015). Bachelor Thesis. Adapted from Anonymous, Bachelor thesis, School of Engineering, Aalto University, Espoo Finland, 2015. This work is licensed under an Attribution-NonCommercialNoDerivatives 4.0 International license.

This style has several inherent problems. To begin with, it significantly limits the writer from utilising what the noted academic writing scholar Ken Hyland (2005) has called stance and engagement within the actual paragraph. This is where the writer adds their own authorial voice to the text by interacting with the source material and with the readership in order to situate themselves in their community of academic peers. This interaction is achieved in the context of stance and engagement by the use of attitudinal markers, boosting, hedging, self-mentioning, directives, personal asides, questions, reader pronouns, and shared knowledge (Hyland 2005, 177). Within this long form Finnish paraphrase, the stance and engagement can logically be attributed only to the original cited source, not the current writer summarising the ideas of the source, for there is no meaningful way to discern ownership of ideas beyond the citation attribution. In example 8 above, it is possible to identify at least 10 separate statements made in the paragraph. Some of these are representative of stance, including claims (e.g., ‘The downside when compared to these methods is. . .’ and ‘This makes it a superior tool. . . and explains why prototyping has been the leading application in AM’) and logical connections (‘Moreover’, and ‘However’). Moreover, there are clear attempts at engagement with asides (e.g., ‘as the names implies’) and creating interpersonal solidarity with experts in the field through boosting (e.g., ‘extremely’ and ‘superior’). While some of these may have been the thesis writer’s own arguments, it would, for the reader, appear that these have all been paraphrased from the source (Wohlers 2013). From a larger perspective, this Finnish paraphrase style tends to promote a less critical style of writing where writers tend to summarise the work of others and avoid critically discussing individual ideas from sources as they are introduced.

Similarly, this Finnish paraphrase style can lead fledgling writers quite easily into practices that constitute plagiarism. For instance, when students write their bachelor’s thesis, it can often take the form of a literature review. When the perceived goal is to

summarise others' ideas, it can readily lead to an overuse of this FPP style. According to the Chicago Manual of Style, this could constitute plagiarism: '(u)se that is not fair will not be excused by paraphrasing. Traditional copyright doctrine treats extensive paraphrase as merely disguised copying' (University of Chicago Press 2017, 212). It is similar to the problem of overuse of block quotes in the arts, humanities, and social sciences.

Worse yet, the logic of the FPP style has led some students to the practice of summarising two or more sources into a single paragraph with the citations provided only at the end of the paragraph. This would certainly constitute plagiarism as there is no meaningful way for the reader to discern which idea or argument belongs to which author. Unfortunately, this logical leap does not appear to be a rare occurrence. In a recent survey of 41 theses written in English at Aalto University between 2008 and 2018, 85% (35 samples) used the FPP style, while the multiple citation problem occurred in 41% (17 samples) (Forget and Paloposki 2019).

While it is generally better to introduce a citation and immediately contextualise it (i.e., integrate it into your argumentation; explain its significance; agree/disagree with it; or contrast it), it is possible to continue discussing a single source without using the same citation at the end of every sentence. For instance, the Publication Manual of the APA (APA 2018) recommends maintaining a clear progression of the topic at the start of the next sentence.

**Example 9:** APA-recommended method of paraphrasing same source across consecutive sentences

Chen and Liu (2004) studied the effect of aggregate size distributions and the volume fraction of aggregate on the fracture parameters of concretes with strength 50–89 MPa under three-point bending test. For this purpose three various maximum aggregate sizes of 10, 15 and 20 mm were employed.

*Source:* Rashad, A. and Seleem, H. (2014). A Study of High Strength Concrete with Moderate Cement Content Incorporating Limestone Powder. *Building Re-search Journal*, 61(1): 43–58. DOI <https://doi.org/10.2478/brj-2014-0004>. This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 3.0 International license.

In example 9, it is clear the Rashad and Seleem are still referring to Chen and Liu's article in the second sentence by starting with 'For this purpose. . . aggregate sizes. . .' Although one would suffice, both noun phrases are clearly connected by topical progression to the narrative of the first sentence.

## References

### References in the Harvard Style

The reference list below contains examples of a scholarly article, book, chapter in a book with editors, conference publication, doctoral dissertation, interview, master's thesis, motion picture, painting, photograph, standard and webpage. These have been

formatted in the American Psychological Association (APA) style, one variation of the Harvard Style. Please note that the APA recommends including the digital object identifier (DOI) for sources found online. When the DOI is missing, they recommend including the home page URL. Although the APA guidelines do not require a date of retrieval, it is good practice to note the date retrieved as online sources can change over time.

American Medical Association. (2007). *AMA Manual of Style: A Guide for Authors and Editors* (10th ed.). New York, USA: Oxford University Press.

American Psychological Association. (2018). *Publication Manual of the American Psychological Association* (6th ed.). Washington, USA: American Psychological Association.

American Sociological Association. (2019). *American Sociological Association Style Guide* (6th ed.). Washington, USA: American Sociological Association.

British Medical Association. (2012). Reference Styles [Webpage]. Updated 28 February 2019. Retrieved 01 March 2020 from <https://www.bma.org.uk/library/library-guide/reference-styles>

Bruce, E. & Hamp-Lyons, L. (2013). Looking for the academic voice: Assessing undergraduate writing. In J. Wrigglesworth (Ed.), *EAP within the higher education garden: Cross-pollination between disciplines, departments and research*. Proceedings of the BALEAP Conference, Portsmouth, UK, 2011. Reading, UK: Garnet Education.

Chernin, E. (1988). The “Harvard System”: a mystery dispelled, *BMJ*, 297(6655): 1062–1063.

Council of Science Editors. (2012). *Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers*. Chicago, USA: University of Chicago Press.

Finnish Standards Association. (2010). SFS 5989, Guidelines for bibliographic references and citations to information sources. Helsinki, Finland: Finnish Standards Association.

Forget, M. and Paloposki, T. (2019). *When academic writing cultures collide: Plagiarism requirements in the English Thesis Seminar at Aalto University*. Paper presented at 3rd International Seminar English as a Medium of Instruction (EMI): embracing pluricultural education, Valencia, Spain.

Halliday, M. (2013). *Halliday’s Introduction to Functional Grammar* (4th ed.). London, UK: Routledge.

Heo, M. and Lee, M. (Producers), & Joon-Ho, B. (Director). (2019). *Parasite* [Motion Picture]. South Korea: CJ Entertainment.

Hyland, K. (2005). Stance and engagement: a model of interaction in academic discourse, *Discourse Studies*, 7(2), 173–192. [doi.org/10.1177/1461445605050365](https://doi.org/10.1177/1461445605050365)

Ilen, E., Groth, G., Ahola, M., & Niinimäki, K. (2019). *Empathy in a Technology Driven Design Process: Designing for Users without a Voice of their Own*. Paper

presented at 8th biannual Nordic Design Research Conference: Nordes 2019: Who Cares?, Espoo, Finland.

International Organization for Standardization. (2010). *Information and documentation – Guidelines for bibliographic references and citations to information resources* (ISO 690:2010(E)) (3rd ed.). Retrieved 01 March 2020 from <https://www.iso.org/standard/43320.html>

Lu, Y. (2018). *Experience goals in designing professional tools: evoking meaningful experiences at work* (Doctoral Dissertation, Aalto University, Espoo, Finland). Retrieved 1 March 2020 from <https://aaltodoc.aalto.fi/handle/123456789/34084>

Modern Language Association. (2016). *MLA Handbook*. New York, USA: Modern Language Association.

Nixon, R. (1977, May 4). Interview by D. Frost (Video recording). David Paradine Productions Ltd., Hertfordshire, U.K.

Oxford University Press. (2012). *New Oxford Style Manual*. Oxford, UK: Oxford University Press.

Patrias, K. (2007). *Citing medicine: the NLM style guide for authors, editors, and publishers* (2nd ed.). Bethesda, USA: National Library of Medicine (US). Retrieved 1 March 2020 from: <http://www.nlm.nih.gov/citingmedicine>

Sutherland-Smith, W. (2019). Is student plagiarism still a serious problem in universities today? In D. Pecorari & P. Shaw (Eds.), *Student Plagiarism in Higher Education* (pp. 47–61). Oxford, UK: Routledge.

Tutal, E. (2015). *Participatory design of visual product identity concepts* (Master's thesis, Aalto University, Espoo, Finland). Retrieved 1 March 2020 from <https://aaltodoc.aalto.fi/>

Unknown. (1904). *Alexander Graham Bell* [Photograph]. Library of Congress Prints and Photographs Division, Washington, U.S.A.

University of Chicago Press. (2017). *The Chicago Manual of Style* (17th ed.). Chicago, USA: University of Chicago Press.

University of Manchester. (2018). Academic Phrasebank [Webpage]. Retrieved 1 March 2020 from <http://www.phrasebank.manchester.ac.uk/>

Van Gogh, V. (1889). *Sunflowers* [Oil on canvas]. Van Gogh Museum, Vincent Van Gogh Foundation, Amsterdam, The Netherlands.

## References in the Vancouver (IEEE) style

The reference list below contains examples of scholarly articles [1, 2], a book [3], a chapter in a book with editors [4], a conference publication [5], a master's thesis [6], a doctoral dissertation [7], a standard [8] and a webpage [9]. Note that the IEEE style allows DOIs, but does not require them. For online references, you should specify the 'accessed date' if it is a webpage that might change. Scholarly articles and theses should not change, and thus the access date is not important for such references.

Today, some periodicals use article numbers [2] instead of ordinary page numbers [1]. Please see [10] for more details.

Referring to interviews or works of art seems very uncommon using the IEEE style and the guide [10] does not mention such references at all.

- [1] J. B. Pendry, “Negative refraction makes a perfect lens,” *Phys. Rev. Lett.*, vol. 85, no. 18, pp. 3966–3969, Oct. 2000, doi: 10.1103/PhysRevLett.85.3966.
- [2] J. Chen, S. Cheng, H. Xie, L. Wang, and T. Xiang, “Equivalence of restricted Boltzmann machines and tensor network states,” *Phys. Rev. B*, vol. 97, no. 8, 2018, Art. no. 085104, doi: 10.1103/PhysRevB.97.085104.
- [3] C. F. Bohren and D. R. Huffman, *Absorption and Scattering of Light by Small Particles*, Weinheim, Germany: Wiley-VCH, 2004.
- [4] V. Yannopapas, A. G. Vanakaras, and D. J. Photinos, “Electrodynamic theory of three-dimensional metamaterials of hierarchically organized nanoparticles,” in *Amorphous Nanophotonics*, C. Rockstuhl and T. Scharf, Eds., Berlin Heidelberg, Germany: Springer, 2013, pp. 119–141.
- [5] T. Joachims, “Optimizing search engines using clickthrough data,” in *Proc. 8th ACM SIGKDD Int. Conf. Knowledge Discovery and Data Mining*, Edmonton, Canada, Jul. 23–26, 2002, pp. 133–142.
- [6] J. Martela, “Lifecycle of Mobile Phones,” M.Sc. thesis, Dept. Materials Science and Engineering, Aalto University, Espoo, Finland, 2019. [Online]. Available: <http://urn.fi/URN:NBN:fi:aalto-201908254898>
- [7] R.J. Garbacz, “A generalized expansion for radiated and scattered fields,” Ph.D. dissertation, ElectroScience Lab., Ohio State Univ., USA, 1968. [Online]. Available: [http://rave.ohiolink.edu/etdc/view?acc\\_num=osu1302723653](http://rave.ohiolink.edu/etdc/view?acc_num=osu1302723653)
- [8] *Simple Mail Transfer Protocol*, RFC 5321, J. Klensin, Oct. 2008, [Online]. Available: <https://tools.ietf.org/html/rfc5321>
- [9] B. Casselman, “Jacob Bernoulli’s zoo,” AMS feature column, <http://www.ams.org/publicoutreach/feature-column/fc-2018-02> (accessed Feb. 6, 2018).
- [10] IEEE, “IEEE Reference Guide,” 2018. [Online]. Available: <https://ieeethorcenter.ieee.org/wp-content/uploads/IEEE-Reference-Guide.pdf>