

Master's Programme in Electronics and Electrical Engineering

# Title of the thesis

A possible subtitle

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**Eddie Engineer**

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**Author** Eddie Engineer

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**Title** Title of the thesis — A possible subtitle

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**Degree programme** Electronics and Electrical Engineering

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**Major** An appropriate major

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**Supervisor** Prof. Pirjo Professori

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**Advisors** Dr Alan Advisor, Ms Elsa Expert (MSc)

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**Collaborative partner** Company or institute name (if relevant)

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**Date** 30 June 2025      **Number of pages** 14+1      **Language** English

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**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.

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**Keywords** For keywords choose, concepts that are, central to your, thesis

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**Tekijä** Eddie Engineer

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

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**Koulutusohjelma** Elektroniikka ja sähkötekniikka

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**Pääaine** Sopiva pääaine

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**Työn valvoja** Prof. Pirjo Professori

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**Työn ohjaajat** TkT Alan Advisor, DI Elsa Expert

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

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**Päivämäärä** 30.6.2025

**Sivumäärä** 14+1

**Kieli** englanti

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### **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.

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**Avainsanat** Vastus, resistanssi, lämpötila

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**Författare** Eddie Engineer

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**Titel** Arbetets titel — Opinnäytteen mahdollinen alaotsikko

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**Utbildningsprogram** Elektronik och electroteknik

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**Huvudämne** Sopiva pääaine

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**Övervakare** Prof. Pirjo Professori

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**Handledare** TkD Alan Advisor, DI Elsa Expert

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**Samarbetspartner** Company or institute name in Swedish (if relevant)

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**Datum** 30.6.2025

**Sidantal** 14+1

**Språk** engelska

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### **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>.

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**Nyckelord** Nyckelord på svenska, temperatur

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## **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 June 2025

Eddie E. Engineer

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## 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.

See the file `thesistemplate.tex` or `opinnaytepoija.tex` for examples and descriptions on the use of various document elements like lists, figures, tables, equations and more.

## 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.

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.

### **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.

Finally, a dummy citation [3] to get a reference to an item in the bibliography.

## References

- [1] Aalto University Learning Centre. *Citation Guide: Making a bibliography*. URL: <https://libguides.aalto.fi/c.php?g=410674&p=2797572> (visited on July 14, 2021).
- [2] R. Bringhurst. *Horizontal Motion. The Elements of Typographic Style*. Point Roberts, WA: Hartley & Marks, 1992, pp. 26, 25–36. URL: <https://smallpressblog.files.wordpress.com/2017/11/bringhurst-elements-selections1.pdf>.
- [3] M. C. Dyson and G. J. Kipping. “The Effects of Line Length and Method of Movement on Patterns of Reading from Screen”. In: *Visible Language* 2.2 (Mar. 1998), pp. 150–181.
- [4] Wikipedia contributors. *Line length*. July 22, 2004. URL: [https://en.wikipedia.org/w/index.php?title=Line\\_length&oldid=997524503](https://en.wikipedia.org/w/index.php?title=Line_length&oldid=997524503) (visited on May 7, 2021).

## 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.

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 ??.

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