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**TITLE OF THE BACHELOR’S OR MASTER'S THESIS IN CAPITAL LETTERS, BOLD TYPE, LEFT-ALIGNED, STARTING 11 CM FROM THE TOP OF THE PAGE**

Possible subheading

Lappeenranta–Lahti University of Technology LUT

Your degree programme and thesis type (e.g. Bachelor’s Programme in..., Bachelor's thesis)

If relevant: The name of your Bachelor’s or Master’s programme (e.g. Master’s programme in Water Technology)

202X

Author’s first name and last name

Examiner(s): Title, First name and Last name (e.g. Professor John Smith)

First name, Last name and degree (e.g. Jane Smith, D.Sc. (Tech.))

ABSTRACT

Lappeenranta–Lahti University of Technology LUT

Your school: LUT Business School / LUT School of Energy Systems / LUT School of Engineering Sciences

Your degree programme: Business Administration / Chemical Engineering / Computational Engineering / Electrical Engineering / Energy Technology / Environmental Technology / Industrial Engineering and Management / Mechanical Engineering / Social Sciences Software Engineering

If relevant (double and triple degrees), In co-operation with partner university/universities: Name of the university/universities

Author's name

**Thesis title in English in bold type (possible subtitle included)**

Master’s/Bachelor’s thesis

Year of completion of the thesis

xx pages, xx figures, xx tables and xx appendices

Examiner(s): Title First name Last name and Title First name Last name (Example: Professor John Smith and Jane Smith, D.Sc. (Tech.))

Keywords: List keywords that define the content of the thesis and help find it.

Use single line spacing in your abstract and justify the text as you would the rest of your thesis text body. The abstract and its identifying information must fit on one A4 page. The abstract is a public document, and therefore, you need to exclude any confidential information from it.

The abstract is an independent summary of the thesis and should be intelligible as such, without the original document.

A good abstract is written in complete and concise sentences. Do not express personal opinions in the abstract – describe the thesis as an outside reporter would. Do not make detailed references to the original text. Present the key results of the research.

If you have not received your basic education in Finnish or Swedish and are writing your final thesis in English, write your abstract only in English.

TIIVISTELMÄ

Lappeenrannan–Lahden teknillinen yliopisto LUT

Oma schoolisi: LUT-kauppakorkeakoulu / LUTin energiajärjestelmien tiedekunta / LUTin insinööritieteiden tiedekunta

Oma koulutusohjelmasi: Energiatekniikka / Kauppatieteet / Kemiantekniikka / Konetekniikka / Laskennallinen tekniikka / Sähkötekniikka / Tietotekniikka / Tuotantotalous / Yhteiskuntatieteet / Ympäristötekniikka

Mikäli yhteistutkinto-ohjelma, Yhteistyöyliopisto: Yliopiston nimi

Tekijän nimi

**Työn suomenkielinen nimi lihavoituna (myös mahdollinen alaotsikko)**

Koulutusohjelmasi ja tutkielmasi: esim. Kauppatieteiden pro gradu -tutkielma / Konetekniikan kandidaatintyö

Vuosiluku

xx sivua, xx kuvaa, xx taulukkoa ja xx liitettä

Tarkastaja(t): Titteli Etunimi Sukunimi ja Titteli Etunimi Sukunimi

Avainsanat: Listaa tähän avainsanat, joiden perusteella tutkielma voi haettaessa löytyä

Tiivistelmätekstin riviväli on 1, ja se tasataan molempiin reunoihin, kuten muukin opinnäytetyön leipäteksti. Tiivistelmätekstin tunnistetietoineen on mahduttava yhdelle A4-arkille. Tiivistelmään ei voi sisällyttää salassa pidettäviä tietoja, vaan se on aina laadittava julkiseksi.

Tiivistelmä on itsenäinen esitys tutkielmasta, ja sen tulee olla ymmärrettävissä sellaisenaan. Hyvässä tiivistelmässä virkkeet ovat täydellisiä, lyhyitä ja ytimekkäitä. Tekijän mielipiteet eivät näy, vaan hän kuvaa työtään kuin ulkopuolinen raportoija. Tiivistelmässä ei viitata yksityiskohtaisesti alkuperäistekstiin. Tutkimuksen keskeisimmät tulokset sisältyvät tiivistelmään.

Opiskelijat, joiden koulusivistyskieli ei ole suomi tai ruotsi ja jotka kirjoittavat opinnäytteensä englanniksi, kirjoittavat tiivistelmän ainoastaan englanniksi.

ACKNOWLEDGEMENTS

(Optional)

You may thank people and your thesis commissioning company who have supported you in your work on the thesis. Please note that it is inappropriate to express any personal (e.g. political or religious) statements in a thesis, even in the acknowledgements.

SYMBOLS AND ABBREVIATIONS

(A list of symbols and/or abbreviations is possible, but not relevant for all works. Note: the list below gives some examples of variables, but the author should define all variables according to research practice of the field. In some situations, this may be challenging as there are no universal guidelines for defining variables. See the [style guide for SI units](https://physics.nist.gov/cuu/Units/checklist.html).)

Roman characters

*p* pressure bar, Pa

*qm* mass flow rate kg/s

*R* gas constant J/kg K

*T* temperature ºC, K

*U* voltage V

*V* volume m3

*v*  specific volume m3/kg

*x* vapour content

Greek characters

*α* incidence angle °

λ thermal conductivity W/mK

Constants

g gravitational acceleration 9,81 m/s

Dimensionless quantities

Re Reynolds number

Subscripts

1 inflow

2 outflow

kr critical

mit measured

Superscripts

*'* stator

*"* rotor

Abbreviations

CFD Computational Fluid Dynamics

ORC Organic Rankine Cycle

**Table of contents**

Abstract

(Acknowledgements)

(Symbols and abbreviations)

Declarations

[1 Introduction 10](#_Toc90385276)

[2 Second chapter 11](#_Toc90385277)

[2.1 First section 11](#_Toc90385278)

[2.1.1 First subsection 11](#_Toc90385279)

[2.1.2 Second subsection 11](#_Toc90385280)

[2.2 Second section 12](#_Toc90385281)

[3 Third chapter 13](#_Toc90385282)

[3.1 First section 13](#_Toc90385283)

[3.1.1 First subsection 13](#_Toc90385284)

[3.1.2 Second subsection 13](#_Toc90385285)

[3.2 Second section 13](#_Toc90385286)

[4 Conclusions 14](#_Toc90385287)

[References 15](#_Toc90385288)

Appendices

Appendix 1. Text processing and layout in a thesis

Appendix 2. References

Appendix 3. Tables, figures, equations, numbers, symbols and abbreviations

Appendix 4. Appendices

Appendix 5. Publication

Figures

Figure 1: Caption

Figure 2: Caption

Tables

Table 1: Caption

NOTE! Lists of figures and tables are optional.

DECLARATIONS

**Turnitin**

The originality of this thesis has been reviewed with the Turnitin similarity checking service.

**AI usage**

The author of this thesis, Firstname Lastname, did not use any AI tools during the preparation of the thesis**.**

OR

The author of the thesis, Firstname Lastname, used the following AI-tools during the preparation of the thesis:

1. AI tool name A
   1. Purpose of use:
   2. Explanation of the use of the tool:
2. AI tool name B
   1. Purpose of use:
   2. Explanation of the use of the tool:

NOTE! Record all the AI tools you have used in the same way.

**Responsibility**

The author, Firstname Lastname, takes full responsibility for the content of this thesis and has reviewed and edited the content generated by the possible use of AI tools.

1. Introduction

Two-switch forward converter or double-ended forward converter

* In the “off” state, both transistors are subjected to only the DC input voltage rather than twice that, as in the single-ended converter.

1. Second chapter

Give a brief introduction to what each chapter is about. Write at least two sentences under the chapter heading.

* 1. First section

Give each chapter and section a title that describes their content. You need to write something under the heading. In other words, you cannot have one heading after another without text in between. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section.

“This is an example of a direct citation where the line spacing can be smaller than in the rest of the text body. This is an example of a direct quote. This is an example of a direct quote. This is an example of a direct quote. This is an example of a direct quote. This is an example of a direct quote.” (Source 2021, 45.)

This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section. This is an example sentence for the first section.

* + 1. First subsection

This is an example sentence for the first subsection. This is an example sentence for the first subsection. This is an example sentence for the first subsection. This is an example sentence for the first subsection.

* + 1. Second subsection

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

* 1. Second section

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

1. Third chapter

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

* 1. First section

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

* + 1. First subsection

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

* + 1. Second subsection

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

* 1. Second section

Text text text text text text text text text text text text text text text text text text text text text text text text text text text text text

1. Conclusions

The conclusions explain how well your research achieved its objectives, what its findings were and what they mean in a wider perspective and for the future. The conclusions should examine how your findings differ from or coincide with those of previous studies. Analyse the impact of your research: its theoretical or practical contribution and wider societal importance. In addition, mention possible limitations of your study and research topics that should be dealt with in the future.

Remember that if or when someone other than your supervisor reads your thesis, they will most likely read the introduction and conclusions first.

References

Hansen, E. B. & Bøgh, S. (2021). Artificial intelligence and internet of things in small and medium-sized enterprises: A survey. Journal of manufacturing systems, 58, 362–372. Saatavissa DOI: 10.1016/j.jmsy.2020.08.009.

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Note: More information on referencing is available in Appendix 2.

Appendix 1. Text processing and layout in a thesis

Good text processing skills make writing your final thesis and using this template easier. Therefore, you should make sure you have the sufficient basic skills to edit long documents with text processing software before you start. This involves applying the styles, understanding automatic referencing and knowing how to divide your text into sections.

The essential thing is to understand the following basics of Word:

* Do not modify your layout by adding consecutive spaces or line breaks. If you need to press Enter or the space bar more than once, you are probably doing something wrong. When you want to start a new paragraph, press Enter once at the end of the sentence and use styles to create a space between the paragraphs.
* Do not do numbering manually. Word has efficient automatised tools for this. Section numbering and page numbering are applied in this template but also automatised numbering of figures/tables is possible. They keep the numbers in the right order even if you modify, add or remove information.
* Do not add hyphenation at the end of a line manually. Word’s automatic hyphenation tool can be used in this template. If you need to add more hyphens, select manual hyphenation in Word. The automatic hyphenation is usually turned off, but you can activate it yourself.

Line spacing, font, margins, alignment, page numbering and headings

Official layout guidelines state that the line spacing should be 1.5 except for the abstract and possible direct citations, where the spacing is 1. You can choose from two fonts: Times New Roman (12 pt) or Arial (11 pt). This template has been written in Times New Roman 12 pt (Style LUT Normal). Leave an empty line before and after tables and figures.

Leave the following margins:

• top and left 35 mm

• bottom and right 20 mm.

The page number of the title page is 1, but the page numbering should not be visible before the first page of the table of contents. Place the page numbers at the top of the page, either centred or in the right-hand corner. Page numbering ends on the final page of the reference list: appendices do not have page numbers unless the appendix is multiple pages.

Always use heading styles in your headings (LUT Heading 1, LUT Heading 2, LUT Heading 3). Always place chapter headings (LUT Heading 1) on a fresh page. If you add large figures or tables, remember to check that the empty space after the figure or image covers no more than 20% of the page.

The heading numbering starts from the introduction and continues consecutively. Do not place a period after the heading number. Do not number the heading of the reference list at the end of the thesis.

The thesis should include no more than three heading levels, and the headings should progress in a logical order (first LUT Heading 1, then LUT Heading 2, etc.). If you need even more detailed subheadings, do not number them, and leave them out of the table of contents. Concise headings that describe the text sufficiently are the best. You can use question marks or exclamation marks, but do not add a period if the heading is a regular sentence.

A heading cannot be followed by a heading. Always write something between them. For instance, there must be text between headings 1 and 1.1.

Lists are a good way to express things clearly. Use the same type of bullet or symbol in lists throughout your thesis. A section should never end in a list. There should always be two or three sentences after a list.

Appendix 2. References

The text must include references to the sources you use. LUT University applies the Harvard referencing style, also called the author-date style with in-text referencing and a detailed reference list at the end.

The purpose of a reference is to provide sufficient information on a source used in the study, allowing the reader to consult the original source for further information. The reference enables the reader to find detailed information on the source easily in the list of references. You should refer to the original and most recent sources. If no new studies have been published on the topic in question, also older ones may be used.

Referring to a source means that you explain the contents of the source material in your own words. Direct citations, on the other hand, are placed in parentheses (“ ”). Plagiarism or using another person’s original material without appropriate referencing is not allowed.

Referencing technique

In the Harvard system, the citation is placed in parentheses directly in the text to indicate the passage that has been cited from another source. Place the citation before the period that ends the sentence when it refers only to the sentence in question (Kaasinen et al. 2020, 173–174). If you are referring to more than that one sentence, introduce the source you are summarizing or paraphrasing at the beginning of the paragraph. Then, refer back to the source when needed to ensure your reader understands you are still using the same source.

Typically, the citation mentions the author (the last name is sufficient, unless authors of several sources have the same last name), the publication year and the page number. Please note that the author does not always have to be a person, but it may also be an organisation, for instance. If the source does not mention who the author is, the reference should include the name of the publication instead of the author. The author (or the title of the work) is very commonly mentioned as a part of a sentence: “According to a study conducted by Möttönen (2007, 68), a pike is a fish”.

If the source has more than one author, typically they are all mentioned in the reference by their last name and separated with the word ‘and’ or the symbol ‘&’. Make later references to the same work with the first author’s last name and “et al.” If you reference several works published by the same author in the same year, add lower-case letters (a, b, c…) after the publication year to distinguish the sources. Use the same alphabetical organisation also in the list of references.

There are several referencing and citation styles. It is essential to consistently use the same style throughout the thesis.

The LUT citation guidelines and examples are available on library’s guide: [Citing and using sources - LUT](https://libguides.lut.fi/LUTcitation).

Appendix 3. Tables, figures, equations, numbers, symbols and abbreviations

It is a good idea to illustrate your text with figures and tables. Figures and tables must have captions and consecutive numbering. The captions of tables are placed above the table and those of figures below the figure. In many theses, figures and tables are centralised. The author can choose how to place the tables and figures, as long as the method is consistent and continuous throughout the work. Refer to the figures and tables in the text body, preferably before you introduce them, and align them with the text body.

Remember to add alt text (alternative text) to your figures and tables to ensure accessibility. Alt text is read with a designated reader and can be viewed even when the image cannot be displayed on the page. The MS Word text processing software creates alt text automatically, but you should make sure it describes the object sufficiently and understandably. You can modify the alt text by right-clicking on the figure or table.

Tables

Give your tables numbers and captions, and refer to them in the text. Place the caption above the table, name its columns and mention the units applied, as in Table 1 below. Avoid empty columns or rows. The recommended font size is 10.

Table 1. Sensor measurements

|  |  |
| --- | --- |
| Voltage *U* [V] | Pressure *p* [Pa] |
| 0.984 | 0 |
| 2.252 | 150 |
| 2.772 | 300 |
| 3.181 | 450 |
| 3.615 | 600 |
| 3.817 | 750 |
| 4.088 | 900 |

Figures, charts, graphic elements

Images help illustrate your text. The text should contain a reference to the image (Figure 1). Number your figures and place a caption underneath – not inside the figure.

You should use a software programme such as Excel or Matlab to draw charts. Charts should be clear and easy to understand. Use a white background. A background grid is allowed if it does not make the figure difficult to interpret. Variables and measurement points should be clearly visible. Name the axes and their units.

Create as much of the figures yourself as you can. Use the same font as in the text body and equations. If you use images created by someone else, remember to cite them correctly. Remember that images are copyrighted works, the use of which must always be authorized by the author. Captions need to be in the same language as the text body.

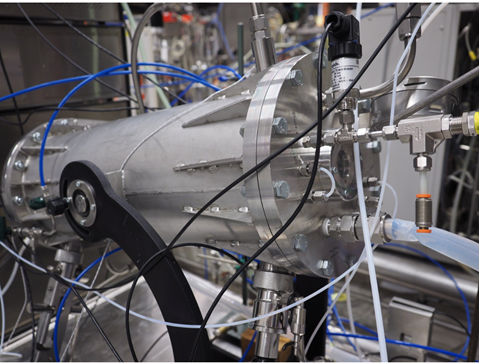


Figure 1. Gas fermentor (VTT 2020, LUT image bank).

Do not end a paragraph in a figure or table. Add text underneath, such as comments on the figure. Large figures, tables, long equations and other supporting material can be appended, if needed.

Numbers, symbols and equations

Numbers in the text are usually approximations. Their accuracy depends on the observational error. Include only significant figures in the results. Interim results should include at least two figures more to avoid round-off errors. Present large and small figures in powers of ten 10ⁿ, where n should preferably be divisible by three.

Equations and other mathematical expressions must consist of standardised symbols if ones exist. You may use other symbols only if there are no applicable standardised or established ones.

Explain the symbols in an equation when you use them for the first time. Write each equation clearly on its own line and indent it. Number your equations consecutively or by paragraphs so that the number is in parentheses on the right side of the equation and aligned to the right. You can refer to an equation only after you have presented it, with certain exceptions, such as if the object you are referring to is far ahead. Example:

*pv* = *RT* (1)

where *p* is pressure (Pa), *v* is specific volume (m³/kg), *R* is the gas constant (J/kgK) and *T* is temperature (K).

When writing symbols for your thesis, it is recommended to check the spelling with the MS Word equation editor. It follows general rules for the writing of symbols, e.g.

* Write scalars in italics and vectors in bold, not in italics. Don’t write dimensionless quantities in italics.
* Write subscripts upright unless there is a need to italicise them. Write abbreviated subscripts and numerals e.g. as follows: Δ*σ*w*, σ*1*, σ*min. For instance, in the summation the subscript needs to be italicised because it represents a variable.
* If you wish to express change in e.g. pressure Δ*p*, write Δ in a regular font. In some cases, *Δ* may also be a variable and should then be italicised. π is the ratio of a circle’s circumference to its diameter. *π* may be the pressure ratio.
* Do not italicise mathematical operators such as sin *x* or lg *y.*
* Distinguish absolute values as follows: ”variable\_=\_number\_unit”, with the exception of a percentage sign after a numeral, e.g. *a* = 5.2 mm, *γ* = 97.7%.
* Use a decimal point (“.”) in accordance with international standards. In contrast, a decimal comma is used in theses written in Finnish. This also applies to figures and tables.

List of symbols and abbreviations

List symbols and abbreviations and their definitions that are not common knowledge separately on their own page before the table of contents. Divide them into groups: Roman symbols, Greek symbols, and finally, abbreviations. Give the page the heading Symbols if there are no abbreviations or Abbreviations if there are no symbols.

When you use a symbol or abbreviation in the text body for the first time, introduce it to the reader for example as follows: “The concept design for manufacturing and assembly (DFMA) is...”. After this, you can use only the abbreviation, and the reader can verify its meaning from the abbreviation list. Do not add concepts to the list of symbols and abbreviations that you do not mention in your text body.

Appendix 4. Appendices to the thesis

Appendices may include e.g. interview questions, survey forms or other content relevant to the work but not necessary to include in the text body. All appendixes are public and should not contain confidential information.

In your text body, refer to the appendices by adding their title in parenthesis (Appendix 1) where relevant. Give all appendices a title based on their content and list them in the table of contents in the order in which they are referred to in the thesis.

Single-page appendices do not require page numbering. Multiple-page appendices do.

Appendix 5. Publishing the thesis

LUT’s degree regulations state that Bachelor's and Master's theses are public documents. They are published in the LUTPub repository, and related instructions are available on the [library web site](https://libguides.lut.fi/lutpub-en/thesis).

Together with the first examiner, make sure that the commissioner of your thesis is aware of the publicity requirements from the very beginning of the discussions. The student writing the thesis and the thesis commissioner are responsible for ensuring that there is no confidential material in the thesis. The background material of the thesis may contain confidential contents. The background material is not public.

All theses in LUTPub must fulfil accessibility requirements. Your text must be as legible as possible to readers. Remember

* to use styles to create headings,
* embed hyperlinks into your text or a description of the linked content; do not include URL addresses,
* add/check the alt text of your figures and tables describing briefly the main content in writing.

Remember to check and complete the metadata of the thesis text file, e.g. the name of the work and the author (File 🡪 Info 🡪 Properties 🡪 Advanced properties 🡪Summary).