
AN INCREDIBLY INSIGHTFUL THESIS ABOUT SOMETHING EXTREMELY IMPORTANT

PRESTIGIOUS INSTITUTE OF SOMETHING IMPORTANT
DEPARTMENT OF VERY ADVANCED THEORETICAL STUFF



DOCTORAL THESIS

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Dedication

Acknowledgments

Abstract

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CHAPTER 1

Text and Structure

1.1 Paragraphs of Text

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1.2 Text Styling

Bold, *Italic*, Underline, Monospaced, *Emphasized*

1.3 Quotations

This is an inline quote: “This is quoted.”

This is a block quote. It’s often used for long quoted passages, interviews, or highlighted text.

1.4 Footnotes

Footnotes are useful for adding clarifications, additional references, or brief comments without interrupting the main flow of the text.¹

¹Footnotes should be used sparingly in academic writing and should not contain essential information.

1.5 Hyperlinks

Hyperlinks are used to reference online documentation, datasets, software repositories, or official standards. Whenever possible, links should be embedded in descriptive text rather than shown as raw URLs.

1.5.1 General Example

Comprehensive documentation and tutorials are available on the official L^AT_EX project website (LaTeX Project Website). In cases where the address itself is relevant, a full URL may be displayed explicitly: <https://ctan.org>

1.5.2 Technical Documentation Example

We follow the installation steps provided in², selecting a minimal L^AT_EX distribution instead of a full installation.

1.6 Lists

1.6.1 Numbered List

Numbered lists are useful when the order of items is important or when describing step-by-step procedures.

1. The first item
2. The second item
 - (a) Sub-item one
 - (b) Sub-item two
 - i. Sub-sub-item A
 - ii. Sub-sub-item B
3. The third item

1.6.2 Bullet Points

Bullet point lists are appropriate for unordered items where sequence does not matter.

- The first item
- The second item
 - Sub-item one
 - Sub-item two
 - * Sub-sub-item A
 - * Sub-sub-item B
- The third item

²🔗 <https://www.latex-project.org/get/>

1.6.3 Fontawesome Lists

Custom symbols, such as Font Awesome icons, can be used to visually distinguish list items or emphasize specific categories.

- ⌚ The first item
- ⌚ The second item
 - ⌚ Sub-item one
 - ⌚ Sub-item two
- ⌚ The third item

1.6.4 Descriptions and Definitions

Description lists are used to associate terms or labels with brief explanations or definitions.

Name Description

Word Definition

Comment Elaboration

1.7 Citation

- Papers: [1], [2], [3].
- Books: [4], [5], [6], [7].
- Thesis: [8], [9].

CHAPTER 2

Equations and Symbols

2.1 Inline Math

The Pythagorean theorem is expressed as $a^2 + b^2 = c^2$.

2.2 Displayed Equations

$$E = mc^2 \quad (2.1)$$

2.3 Align Environment

$$f(x) = x^2 + 3x + 2 \quad (2.2)$$

$$= (x + 1)(x + 2) \quad (2.3)$$

2.4 Fractions, Roots, and Exponents

$$\frac{a+b}{c}, \quad \sqrt{2}, \quad x^{n+1}$$

2.5 Summations and Integrals

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}, \quad \int_0^1 x^2 dx = \frac{1}{3}$$

2.6 Greek Symbols

2.6.1 Lowercase Greek Letters

$$\alpha, \beta, \gamma, \delta, \varepsilon, \zeta, \eta, \theta, \iota, \kappa, \lambda, \mu, \nu, \xi, \pi, \rho, \sigma, \tau, \upsilon, \phi, \chi, \psi, \omega$$

2.6.2 Uppercase Greek Letters

$$\Gamma, \Delta, \Theta, \Lambda, \Xi, \Pi, \Sigma, \Upsilon, \Phi, \Psi, \Omega$$

2.6.3 Variant Greek Symbols

$$\varepsilon, \vartheta, \varpi, \rho, \varsigma, \varphi$$

2.7 Matrices

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \quad (2.4)$$

2.8 Systems of Equations

$$\begin{cases} x + y = 1 \\ 2x - y = 3 \end{cases} \quad (2.5)$$

2.9 Numbered Equations with Labels

$$F = ma \quad (2.6)$$

As shown in Equation 2.6, force is proportional to mass and acceleration.

2.10 2 DOF Robot Arm Dynamic Model

El modelo dinámico de un robot manipulador de n grados de libertad está dado por la siguiente expresión:

$$M(\mathbf{q})\ddot{\mathbf{q}} + C(\mathbf{q}, \dot{\mathbf{q}})\dot{\mathbf{q}} + \mathbf{g}(\mathbf{q}) = \boldsymbol{\tau} \quad (2.7)$$

Específicamente para un robot manipulador de dos grados de libertad se tiene:

$$\begin{bmatrix} M_{11}(\mathbf{q}) & M_{12}(\mathbf{q}) \\ M_{21}(\mathbf{q}) & M_{22}(\mathbf{q}) \end{bmatrix} \ddot{\mathbf{q}} + \begin{bmatrix} C_{11}(\mathbf{q}, \dot{\mathbf{q}}) & C_{12}(\mathbf{q}, \dot{\mathbf{q}}) \\ C_{21}(\mathbf{q}, \dot{\mathbf{q}}) & C_{22}(\mathbf{q}, \dot{\mathbf{q}}) \end{bmatrix} \dot{\mathbf{q}} + \begin{bmatrix} g_1(\mathbf{q}) \\ g_2(\mathbf{q}) \end{bmatrix} = \boldsymbol{\tau}, \quad (2.8)$$

Donde:

$$M_{11}(\mathbf{q}) = m_1 l_{c1}^2 + m_2 [l_1^2 + l_{c2}^2 + 2l_1 l_{c2} \cos(q_2)] + I_1 + I_2$$

$$M_{12}(\mathbf{q}) = m_2 [l_{c2}^2 + l_1 l_{c2} \cos(q_2)] + I_2$$

$$M_{21}(\mathbf{q}) = m_2 [l_{c2}^2 + l_1 l_{c2} \cos(q_2)] + I_2$$

$$M_{22}(\mathbf{q}) = m_2 l_{c2}^2 + I_2$$

$$C_{11}(\mathbf{q}, \dot{\mathbf{q}}) = -m_2 l_1 l_{c2} \sin(q_2) \dot{q}_2 \quad (2.9)$$

$$C_{12}(\mathbf{q}, \dot{\mathbf{q}}) = -m_2 l_1 l_{c2} \sin(q_2) [\dot{q}_1 + \dot{q}_2]$$

$$C_{21}(\mathbf{q}, \dot{\mathbf{q}}) = m_2 l_1 l_{c2} \sin(q_2) \dot{q}_1$$

$$C_{22}(\mathbf{q}, \dot{\mathbf{q}}) = 0$$

$$g_1(\mathbf{q}) = [m_1 l_{c1} + m_2 l_1] g \sin(q_1) + m_2 l_{c2} g \sin(q_1 + q_2)$$

$$g_2(\mathbf{q}) = m_2 l_{c2} g \sin(q_1 + q_2).$$

Considerando a $\mathbf{q} = [q_1, q_2]^\top$ y $\dot{\mathbf{q}} = [\dot{q}_1, \dot{q}_2]^\top$ como variables de estado, el modelo dinámico del robot se puede reescribir de la siguiente forma:

$$\frac{d}{dt} \begin{bmatrix} \mathbf{q} \\ \dot{\mathbf{q}} \end{bmatrix} = \begin{bmatrix} \mathbf{0} \\ M(\mathbf{q})^{-1} [\tau - C(\mathbf{q}, \dot{\mathbf{q}}) \dot{\mathbf{q}} - \mathbf{g}(\mathbf{q})] \end{bmatrix} \quad (2.10)$$

CHAPTER 3

Mathematical Environments

3.1 Theorems

This is an example of theorems.

3.1.1 Several equations

This is a theorem consisting of several equations.

Theorem 3.1.1 — Name of the theorem. In $E = \mathbb{R}^n$ all norms are equivalent. It has the properties:

$$|||\mathbf{x}|| - ||\mathbf{y}||| \leq ||\mathbf{x} - \mathbf{y}|| \quad (3.1)$$

$$||\sum_{i=1}^n \mathbf{x}_i|| \leq \sum_{i=1}^n ||\mathbf{x}_i|| \quad \text{where } n \text{ is a finite integer} \quad (3.2)$$

3.1.2 Single Line

This is a theorem consisting of just one line.

Theorem 3.1.2 A set $\mathcal{D}(G)$ is dense in $L^2(G)$, $|\cdot|_0$.

3.2 Definitions

This is an example of a definition. A definition could be mathematical or it could define a concept.

Definition 3.2.1 — Definition name. Given a vector space E , a norm on E is an application, denoted $||\cdot||$, E in $\mathbb{R}^+ = [0, +\infty[$ such that:

$$||\mathbf{x}|| = 0 \Rightarrow \mathbf{x} = \mathbf{0} \quad (3.3)$$

$$||\lambda \mathbf{x}|| = |\lambda| \cdot ||\mathbf{x}|| \quad (3.4)$$

$$||\mathbf{x} + \mathbf{y}|| \leq ||\mathbf{x}|| + ||\mathbf{y}|| \quad (3.5)$$

3.3 Notations

Notation 3.1. Given an open subset G of \mathbb{R}^n , the set of functions φ are:

1. Bounded support G ;
2. Infinitely differentiable;

a vector space is denoted by $\mathcal{D}(G)$.

3.4 Remarks

This is an example of a remark.



The concepts presented here are now in conventional employment in mathematics. Vector spaces are taken over the field $\mathbb{K} = \mathbb{R}$, however, established properties are easily extended to $\mathbb{K} = \mathbb{C}$.

3.5 Corollaries

This is an example of a corollary.

Corollary 3.5.1 — Corollary name. The concepts presented here are now in conventional employment in mathematics. Vector spaces are taken over the field $\mathbb{K} = \mathbb{R}$, however, established properties are easily extended to $\mathbb{K} = \mathbb{C}$.

3.6 Propositions

This is an example of propositions.

3.6.1 Several equations

Proposition 3.6.1 — Proposition name. It has the properties:

$$|||\mathbf{x}|| - ||\mathbf{y}||| \leq ||\mathbf{x} - \mathbf{y}|| \quad (3.6)$$

$$||\sum_{i=1}^n \mathbf{x}_i|| \leq \sum_{i=1}^n ||\mathbf{x}_i|| \quad \text{where } n \text{ is a finite integer} \quad (3.7)$$

3.6.2 Single Line

Proposition 3.6.2 Let $f, g \in L^2(G)$; if $\forall \varphi \in \mathcal{D}(G)$, $(f, \varphi)_0 = (g, \varphi)_0$ then $f = g$.

3.7 Examples

This is an example of examples.

3.7.1 Equation and Text

■ **Example 3.1** Let $G = \{x \in \mathbb{R}^2 : |x| < 3\}$ and denoted by: $x^0 = (1, 1)$; consider the function:

$$f(x) = \begin{cases} e^{|x|} & \text{si } |x - x^0| \leq 1/2 \\ 0 & \text{si } |x - x^0| > 1/2 \end{cases} \quad (3.8)$$

The function f has bounded support, we can take $A = \{x \in \mathbb{R}^2 : |x - x^0| \leq 1/2 + \varepsilon\}$ for all $\varepsilon \in]0; 5/2 - \sqrt{2}[$. ■

3.7.2 Paragraph of Text

■ **Example 3.2 — Example name.** Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris. ■

3.8 Exercises

This is an example of an exercise.

■ **Exercise 3.1** This is a good place to ask a question to test learning progress or further cement ideas into students' minds. ■

3.9 Solutions

This is an example of a solution.

■ **Solution 3.1** The details are left to the reader. ■

3.10 Problems

Problem 3.1 What is the average airspeed velocity of an unladen swallow?

3.11 Vocabulary

Define a word to improve a students' vocabulary.

Vocabulary 3.1 — Word. Definition of word.

CHAPTER

4

Figures and Tables

4.1 Figures

Supported formats include: ‘.png’, ‘.jpg’, ‘.jpeg’, ‘.pdf’, and ‘.eps’ (depending on the compiler). It is recommended to use ‘.pdf’ for vector images and ‘.png’ for raster graphics.

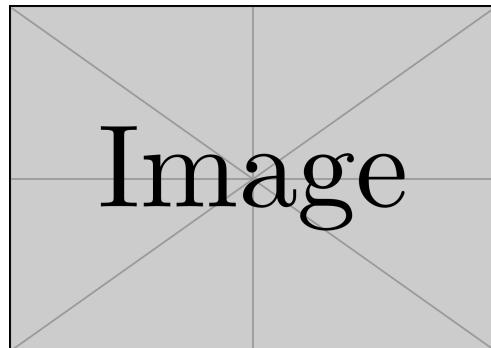


Figure 4.1: A sample figure with a caption.

Refer to Figure 4.1 to cite a full figure in your text.

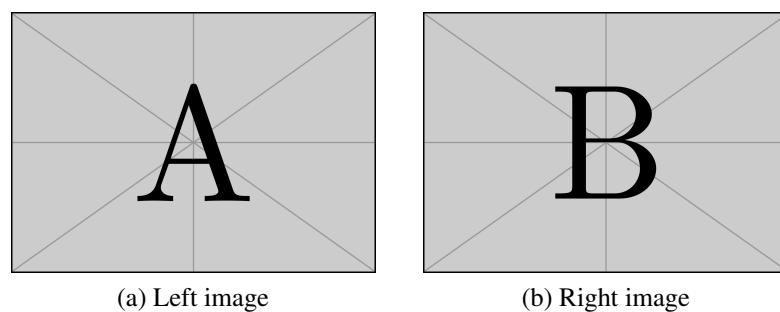


Figure 4.2: Two images displayed side by side.

Refer to subfigures individually as Figures 4.2a and 4.2b, or collectively as Figure 4.2.

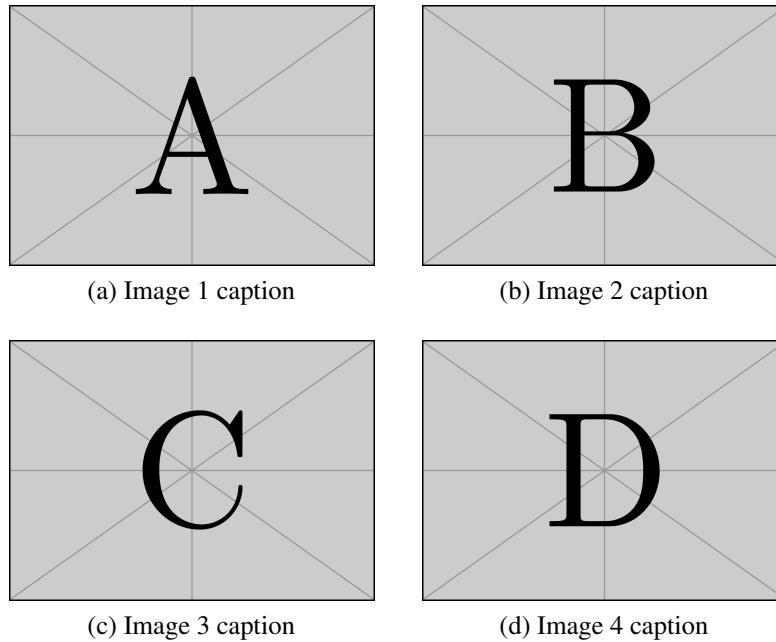


Figure 4.3: Comparison of four different images.

You can reference subfigures individually, such as Figure 4.3b, or the full group using Figure 4.3.

4.2 Tables

Table 4.1: Experimental results for each treatment.

| Treatment | Response 1 | Response 2 |
|-------------|------------|------------|
| Treatment 1 | 0.0003262 | 0.562 |
| Treatment 2 | 0.0015681 | 0.910 |
| Treatment 3 | 0.0009271 | 0.296 |

Table 4.2: Sample parameters with corresponding physical units.

| Symbol | Description | Value | Units |
|--------|--------------------|-------|-------|
| A | Sample parameter A | 12.50 | m |
| B | Sample parameter B | 3.14 | kg |
| C | Sample parameter C | -0.98 | s |

This is an example of referencing a table using its assigned label. As shown in Table 4.2.

CHAPTER 5

Miscellaneous

5.1 Boxes



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5.2 Linux Shell Terminal

Inline bash style C:\Windows\system32

```
$ locale # check for UTF-8

$ sudo apt update && sudo apt install locales
$ sudo locale-gen en_US en_US.UTF-8
$ sudo update-locale LC_ALL=en_US.UTF-8 LANG=en_US.UTF-8
$ export LANG=en_US.UTF-8

$ curl -L -o /tmp/ros2-apt-source.deb "https://github.com/ros-infrastructure/rospack-source/releases/download/${ROS_APT_SOURCE_VERSION}/ros2-aptsource_${ROS_APT_SOURCE_VERSION}.$(. /etc/os-release && echo ${UBUNTU_CODENAME}-${VERSION_CODENAME})_all.deb"

$ ~/home/python/
$ 'a' "b"
```

References

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