

YEDITEPE UNIVERSITY

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| THESIS TITLE |

A  Submitted

by

Name Surname

In Partial Fulfillment

of the Requirements for the Degree of

in

(Type your department here)

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| --- |
| Supervisor Name Surname |
|  |

Istanbul - 2025

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| THESIS TITLE |

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# DECLARATION OF ORIGINALITY

I hereby declare that this thesis is my own work and that all information in this thesis has been obtained and presented following academic rules and ethical conduct. I have fully cited and referenced all material and results as required by these rules and conduct, and this thesis study does not contain any plagiarism. The necessary permissions have been obtained if any material used in the thesis requires copyright. No material from this thesis has been used to award another degree.

To the best of my knowledge and belief, it contains no material previously published or written by another person nor material accepted for the award of any other degree except where due acknowledgment has been made in the text.

I accept all kinds of legal liability that may arise in cases contrary to these situations.

Name Surname

Signature

# ABSTRACT

**THESIS TITLE**

Type your abstract here. The ultrasonic technique can predict residual stress distribution in the Heat Affected Zone (HAZ). This was used for residual stress measurement in previous studies and accepted as a method for residual stress measurement. However, measurements in most of these studies carried on one dimension, which covered a straight line from weld to a base plate. This approach gave limited information about the residual stress distribution through the material. This study performs through-thickness ultrasonic longitudinal wave velocity measurements at predetermined points on the steel plate that covers the whole plate. Velocity data is used for the calculation of residual stress and density. Differences between stressed and stress-free sample velocity values are used with acoustoelastic constant to calculate residual stresses. Density at each measurement point is calculated using the relation between density and longitudinal wave velocity. In addition to the ultrasonic test, the sample was radiographed using an X-ray system. Density variation throughout the sample is obtained after digitalizing radiographs and filtering techniques are applied. Heat Affected Zone’s (HAZ) boundary is observed using 2D density and residual stress distribution data of ultrasonic test and radiographic interpretation. To confirm experimental results, 2D FEM axisymmetric model is generated to simulate the multi-pass welding process. This thermomechanical process is performed by thermal analysis coupled with mechanical analysis.

# ÖZET

**TEZ BAŞLIĞI**

Özetinizi bu alana yazınız. Bundan sonraki metin bir örnektir. Isı tesiri altında kalan bölgedeki artık gerilme dağılımı ultrasonik tekniği kullanılarak öngörülebilir. Bu teknik daha önceki çalışmalarda artık gerilme ölçümünde kullanılmış olup bir artık gerilme ölçüm yöntemi olarak kabul edilmiştir. Fakat birçok çalışmada ölçümler bir boyutlu olarak düz bir hat üzerinde kaynaktan malzemeye doğru gerçekleştirilmiştir. Bu çalışmada, kalınlık boyunca ultrasonik dalga hızı çelik plaka yüzeyinin tamamında daha önce belirlenmiş noktalarda ölçülmüştür. Elde edilen hız değerleri yoğunluk ve artık gerilme hesaplamalarında kullanılmıştır. Gerilme oluşmadan önce ve sonra yapılan hız ölçümlerinin farkı ve akustik elastik sabit kullanılarak artık gerilmeler hesaplanmıştır. Yoğunluk ve boyuna dalga hızı arasındaki bağlantı kullanılarak belirlenen noktalardaki malzeme yoğunluğu tespit edilmiştir. Ultrasonik kontrole ilaveten X-Ray sistemi kullanarak malzemenin radyografi filmi çekilmiştir. Yoğunlukta oluşan değişimleri gözlemleyebilmek amacıyla film dijital ortama aktarılmış ve görüntü işleme yazılımı kullanılarak çeşitli filtreler uygulanmıştır. Ultrasonik kontrol yöntemiyle elde edilen iki boyutlu yoğunluk ve artık gerilme dağılımları ile dijital ortama aktarılmış radyografi filmiyle elde edilen yoğunluk dağılımı kullanılarak ısı tesiri altında kalan bölgenin sınırları tespit edilmiştir. Deneysel sonuçları onaylamak amacıyla çok geçimli kaynak işlemi iki boyutlu ve eksensel olarak bakışımlı sonlu elemanlar modeli kullanılarak analiz edilmiştir.

# DEDICATION

*[Delete if not needed] This page is optional. If you need to write, please do so* ***right here***

# ACKNOWLEDGEMENTS

Type your acknowledgments here. The following text is just used as an example. With immense gratitude, I acknowledge the support and help of Professor Name Surname. Pursuing my thesis under her supervision has been an experience that broadens the mind and presents an unlimited source of learning.

I thank Name Surname and Research Assistants Name Surname.

Finally, I thank my family for their endless love and support, making everything more beautiful.

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# LIST OF ABBREVIATIONS

A System matrixB Input matrix

G Plant transfer matrixG1 Plant disturbance matrix*R*  A closed and bounded region in E

δR Boundary of the region R

δRs s=1,…,p Complementary regular subsurface of the boundary δR, s being a positive scalar

*T*  Sampling time

*U*  Control input

xc Controller state vector

αc, αe Controller and estimator characteristics polynomials

Г Discrete plant control input matrixГ1 Discrete plant noise input matrix

λ Plant delay time or transportation lag

ADD Average detection delay

USA United States of America

RAM Random access memory

ASN Average sample number

i.i.d. Independently and identically distributed

JACS Journal of American Chemical Society

Note: The first letter of each word in the List of Symbols/Abbreviations section does not have to be capitalized. Only the first letter of the first word needs to be capitalized—for example, Game design document (GDD), Random access memory (RAM). The first letter of each word will not be capitalized except for special names, etc. DELETE this NOTE when you are done.

# INTRODUCTION

In this manual, you will find the guidelines to prepare your thesis/dissertation in the correct format. This document can be used as a TEMPLATE as it is written in the required format.

Every thesis must show correctness and clarity of expression. The responsibility for such correctness and clarity rests primarily upon the candidate, but every thesis will be scrutinized for these qualities by the student's thesis supervisor and the Examining Committee.

Although the structure of a thesis may show variances with respect to the discipline it belongs to, the following paragraph describes a general outline for constructing the thesis.

In addition to the sections outlined in the Table of Contents: Abstract, Özet (abstract in Turkish), Acknowledgements, and References, every thesis must include a brief introductory chapter (Introduction) with a separate literature review chapter or chapters. The Introduction section can briefly state the general topic and give some background, define the terms and scope of the topic, outline and evaluate the current situation, identify the importance of the proposed research, state the research problem/questions, and state the research aims and/research objectives, (state the hypothesis), outline the order of information in the thesis. A reasonable number of references must be discussed in the following literature review chapter or chapters. Depending on the research topic, the following chapters may include materials, methods, and experimental sections that describe how the study was conducted. Each thesis must include chapters that present the study’s results and discussions on the results obtained. The results and related discussions can be given in a single chapter (Results and Discussion) , in separate chapters (Results)(Discussion), or in chapters that include separate topics in the study. The results and discussion section (sections) is (are) expected to contain some reference to the literature to emphasize the originality of the work or make comparisons with current literature data. Every thesis must include a Conclusions section presenting the main conclusions from the study results. Conclusions can alternatively be given as a subsection at the end of separate chapters that include the results and discussions of different parts of the study. The Conclusions section may also include Future Work, or Future Work can be given as a separate chapter alternatively.

# GENERAL INSTRUCTIONS

Examples of Title Pages for an M.Sc. thesis are presented on Pages i and ii, respectively. Make sure you fill out your program information correctly.

All copies of the submitted thesis must include the Examining Committee's original signatures on the approval page. The names of the members of the Examining Committee will be listed one below the other **in alphabetical order,** except for the Thesis Supervisor, whose name will be **at the top** of the list. Beside each name, a space for the signature of each examiner should be left. The date at the bottom of the page will be filled by **the Graduate School** [1].

Occasionally, authors would like to dedicate their thesis to their family members, friends or some scientists in their area of research. The dedication page should follow right after the Approval Page. It must be typed in **12 points**, **italic**, and adjusted to right. It must be one sentence and contain three dots (…) at the end of the sentence. Width of the sentence cannot exceed 6.5 cm. It must be typed in maximum 2 lines.

The abstract page should contain the title of the thesis. Title must be typed in 14 points. The abstract should be maximum 1 page in length. The abstract should cover the following points: Statement of the problem, procedure or method, results, and conclusions. Two abstracts, one in English and the other in Turkish should be included. The abstract should contain no tabular material, chemical formulas, or footnotes. Abstracts should not contain references, but author citing is allowed. The Turkish abstract ("Özet") must follow the English abstract in the same format. Examples of abstracts to be included in the thesis are given on Pages iv and v [2].

The thesis is expected to have a "Table of Contents" page for the reader’s convenience. If figures and tables are scattered throughout the text, a separate "List of Figures" (and/or "List of Tables") must be included after the Table of Contents. These lists should include page numbers. Similarly, a "List of Symbols" (or "List of Symbols/ Abbreviations", as appropriate) should be included. Examples of such materials are shown on Pages vi-x. "List of Symbols/ Abbreviations" can contain abbreviations listed alphabetically as a separate group following the symbols. Symbols must be separated into two groups as Greek symbols following Latin symbols.

The thesis's first chapter (in most cases, the Introduction chapter) will start on the first page of the text, i.e., the first page enumerated in Arabic numerals. When writing your thesis, pay attention to some of the precautions listed below:

* The whole text should be justified (Ctrl+J).
* Please note the spelling of "Foreword".
* Check your English text for grammar, spelling, and punctuation errors with Word or similar features.
* The word "data" is plural and requires a plural verb.
* Integers from one to nine, inclusive, should be spelled out except when they represent a chapter or a section; for numbers 10 and above, use numerals. Numbers should be spelled out when they begin a sentence.
* The guideline suggests using numerals with the percent sign(%) for technical content. But, use the word percent if the number appears at the start of the sentence with a spelled-out number. For example, *Ninety-five percent of the native trees and 75% of the feed crops survived the drought.*
* Equations must be centered and equation number must be written with chapter number. Equation font should be Cambria Math and font size can differ according to the instructions from author's thesis supervisor. An example of an equation is presented in Equation (3.1) on Page 9.

# FORMAT

After the main heading, it is required that a short description text is given before the next subheading.

## CHARACTER FONTS

As a character font, use Times New Roman. The font size must be 12 pt in the text including formulas, equations, table headings, and figure captions. At least 8 pt should be used in figures, tables, and super or subscripts. Footnotes, long biographical quotes, and extensive quotations should be 10 pt [3].

## SPACING

Spacing of the text material shall be 1.5 or when necessary integer multiples thereof. Body text must follow paragraph properties: 1.5 Line spacing, Before 0 pt, After 10 pt spacing.

Also;

* Footnotes - single spacing (Page 8)
* Long biographical quotes - single spacing
* Extensive quotations - single spacing and indented one (1) centimeter relative to the text material (Page 12)

## LEFT ADJUSTING

The left adjusting point of titles and headings shall be 35 mm from the left edge of the paper. You can use the appropriate left adjusting command in computer typesetting.

## MARGINS

Margins of pages shall conform to the following specifications:

* Left margin - 3.5 cm from the edge of the paper
* Right margin - 2 cm from the edge of the paper
* Top margin - 3.5 cm from the edge of the paper
* Bottom margin - 2 cm from the edge of the paper

The margins must be observed on charts, graphs, tables, and drawings. Folded papers will not be accepted unless there is no other way to present the material.

## PAGINATION

Each page in the thesis (except the title page) is expected to bear a number. Only one side of the paper may be used. The preliminary section, including the title page, copyright page, if any; foreword, preface, or acknowledgments; table of contents, etc., should be numbered, using **lowercase Roman Numerals**, e.g., i, ii, iii, etc. The title page counts as Page i, but the number does not appear[4]. The sequence of the preliminary section is shown in Table 3.1:

Table 3.1. Sequence of the preliminary

|  |  |
| --- | --- |
| Title Page | Page i number does not appear |
| Page of Approval | Page ii |
| Declaration of Independent Work | Page iii |
| Foreword-Dedication, Preface, or Acknowledgements | Page iv as necessary |
| Abstract | Page v as necessary |
| Özet | Page vi as necessary |
| Table of Contents | Page vii, viii as necessary |
| List of Figures | Page viii, ix as necessary |
| List of Tables | Page ix, x as necessary |
| List of Symbols / Abbreviations | Page x, xi as necessary |

For the remainder of the thesis, Arabic numbers are used. Each page must be numbered. **Page numbers must be placed two centimeters from the top and right-hand margins on the pages and must be 12 points.** Include all pages for illustrations, tables, appendices, bibliography, etc. Use of suffixes, such as 25a, 25b, etc., will not be approved. The numbering in the main body of the thesis should begin with Page 1 and run consecutively to the last page. No punctuation, such as a dash or a period, should accompany the page number.

**Paragraphs must start without indentation.** Series of paragraph items that are to be listed without headings under any of the regular headings may, for clarity, be designated by special bullets such as “●”or enumerated by (i), (ii), (iii), etc [5]. **A new paragraph must not begin at the bottom of a page if there is not sufficient space for at least two text lines.**

## HEADINGS

### Main Headings

Main headings numbered such as 1., 2., etc., must obey the following rules:

* They **must begin a new page**. Omit the period at the end of the heading. Main headings must be typed in **boldface** and must be in **capital letters and in 14 points**.
* Main headings should reflect the content of the text that follows. Main headings are not to be called chapters.
* The number of the headings will be followed by **a period** **and** **a tab**.
* The format for the heading must follow 1.5 Line spacing, Before 24 pt and after 24 pt spacing.

### Second Headings

Second headings numbered such as 2.1., 2.2., etc. must obey the following rules:

* They must begin according to Section 3.3 and be typed in **12 points, boldface and, capital letters**; i.e., the first letter of each word except conjunctions, prepositions, and articles must be a capital letter. Omit period at the end of the heading.
* The number designation of the second heading will be followed by a period and a tab.
* Second headings must follow the following format: 1.5 Line spacing, Before 24 pt, After 24 pt spacing, but **need not begin a new page**.

### First Subheadings

First subheadings numbered such as 2.1.1., 2.1.2., etc. must obey the following rules:

* They must be typed on separate lines beginning at the left margin line of the text but **need not begin a new page**.
* They must be typed in **boldface**, left justified, and with capital and **lowercase letters**.
* The number designation of the heading will be followed by **a period and a tab**. Omit the period at the end of the heading.
* First subheadings must follow the following format: 1.5 Line spacing, Before 24 pt, After 24 pt spacing, but **need not begin a new page**.

### Second Subheadings

Second subheadings numbered such as 2.1.1.1., 2.1.1.2., etc. must obey the following rules; however, second subheading, should be avoided if possible.

* They must be typed on separate lines beginning at the left margin line of the text.
* They must be typed in 12 points, boldface, italic, left-justified, and with capital and lowercase letters except for conjunctions, prepositions, and articles.
* The number designation shall be followed by a period and two spaces.
* Second subheadings must follow the following format: 1.5 Line spacing, Before 0 pt, After 10 pt spacing, but **need not begin a new page**.
* Use of third subheadings numbered such as 2.1.1.1.1 and 2.1.1.1.2., etc. is not allowed. Instead, unnumbered subheadings with the following format may be used: bold, first letters capital, left-aligned, 1.5 Line spacing, Before 0 pt, After 10 pt. *e.g.* **Complementary Methods.** These subheadings must not be listed in the Table of Contents.

## FOOTNOTES

Footnotes should obey the following rules; however, footnotes should be used only if absolutely necessary:

* Footnote references shall be indicated in the text by an Arabic number placed superior to the text and immediately following the word, phrase, or sentence the footnote concerns.
* Footnotes shall be sequential for each page and the entire thesis.
* Footnotes[[1]](#footnote-1) shall be placed at the bottom of the page on which they are indicated. They shall be **indented from the left margin** of the text by **one centimeter** and **placed under a broken line made of 20 characters** (5 cm). Footnotes shall be **single-spaced and 10 points**.

## BIBLIOGRAPHICAL MATERIAL

Citations and references shall be in the correct format:

* The number in square brackets such as "[8]", should indicate the order of first appearance of the reference in the text. The listing of references in the bibliography shall be in the order in which they are used in the text and shall bear the same number as was used in the reference in the text as illustrated in Page 16[6].
* When multiple references have to be cited, they can be given in one of the following formats: [6-8] or [6,7,8], [3,12-14] or [3,12,13,14].
* References not cited in the text should be given separately under a new title.
* References should be written in the same format as the examples on Page 16. Reference text should be justified.
* Reference text must follow 1.5 Line spacing, Before 0 pt, After 10 pt spacing

## SPECIALLY DESIGNATED EXPRESSIONS

Specially designated expressions usually mean equations, formulae, etc. and they obey the following rules:

* They will be centered on the page according to Section 3.3 and separated from the preceding text and the succeeding text as if they are a new paragraph (See Section 3.2).
* The expressions shall be identified by an Arabic number in parenthesis like "(2.1)", "(2.2)", "(2.3)", etc., which should be placed opposite the expression and in line with the right margin of the text. They should be numbered within each chapter in the order of their appearance[7].
* Mathematical formulae and expressions must be typeset according to a consistent math-style throughout the whole thesis. The standard style for mathematical expressions in scientific publications makes use of italic typeface for variables in Latin characters and non-italic typeface for mathematical signs (+, -, parenthesis, etc.). Bold characters are usually reserved for vectors and matrices. In any case, the style used for in-text formulae should be the same as that of displayed formulae, see Equations (3.1), (3.2) and (3.3).

|  |  |  |
| --- | --- | --- |
|  | $$Φ\_{1}\left(\genfrac{}{}{0pt}{}{x\_{1}}{x\_{2}}\right)=\left\{\begin{array}{c}\left(\genfrac{}{}{0pt}{}{4-x\_{2}+\left|x\_{1}-x\_{2}\right|}{4-x\_{1}+\left|x\_{1}-x\_{2}\right|}\right) if \sqrt{x₁^{2}+x₂^{2}} >2\\\left(\genfrac{}{}{0pt}{}{x₁}{x₂}\right) otherwise\end{array}\right.$$ | (3.1) |
|  | $$a^{2}+b^{2}=c^{2}$$ | (3.2) |
|  | $$A=πr^{2}$$ | (3.3) |

## TABLES AND FIGURES

In general, all of these are special matters, usually of a technical sort, and the proper form must be understood and followed after a candidate has received instructions from his/her thesis supervisor, as illustrated. To ensure satisfactory reproduction, drawings, graphs, etc., should be prepared in contrasting colors, preferably black.

|  |
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|  |

Figure 3.1. Caption about first image

Table 3.2. Caption about table construction years of the monuments religious and official antiquities in Heybeliada [12].

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Action** | **Sensitivity****(%)** | **Specifity****(%)** | **Total postural transitions** | **Type of subject** |
| lying | 100 ± 0 | - | - | Young and healthy(10 subjects) |
| StSi | 92 ± 9 | 85 ± 11 | 42 ± 0 |
| SiSt | 85 ± 11 | 92 ± 9 |
| walking | 100 ± 0 | - | - |
| lying | 100 ± 0 | - | - | Elderly and healthy(10 subjects) |
| StSi | 89 ± 8 | 83 ± 11 | 42 ± 0 |
| SiSt | 83 ± 11 | 89 ± 8 |
| walking | 98 ± 1 | - | - |

Tables and figures should be enumerated within each chapter, i.e., as 2.1, 2.2, 2.3, 3.1, 3.2, etc. The designation of each table or figure within the text should have only the first letter in the capital (i.e., such as "Table 2.2" or "Figure 5.7") throughout the thesis. Tables, figures, and their captions should be centered, as shown in the examples. The captions should be as normal text, i.e., only the first letter should be capitalized. The caption format should follow 1.5 Line spacing Before 12 pt, After 24 pt for a Figure caption, and 1.5 Line spacing Before 24 pt and After 12 pt for a Table caption. There should be no blank lines before or after the Figure or Table Caption. There should not be a blank line before a boxed figure itself. However, there must be a blank line after the table itself.

|  |  |
| --- | --- |
|  (a) |   (b) |
|  (c) |

Figure 3.2. Caption about multiple images. (a) First of multiple images, (b) Second of multiple images, (c) Third of multiple images.



Figure 3.3. Growth curves of the wild type (AS102), wild type (AS107), and recombinant AS102-57

## QUOTATIONS

Quotations as a paragraph should be separated from the original text of the thesis. It must be typed in 10 points. A new quotation must not begin at the bottom of a page if there is insufficient space for at least two text lines. Quotations must also be separated 1 cm from left and right margins, as illustrated in the example.

The welding heat affects the microstructure of the affected zone and melted zone. This effect causes the variation in ultrasonic wave propagation velocity. The effect of microstructure should be considered during the residual stress measurements. Acoustoelastic constant is determined as the relation between the total residual stresses normal to the wave propagation and ultrasonic wave velocity variation. This constant is calculated by observing wave velocity variations.

## ALGORITHMS

A new algorithm must not begin at the bottom of a page if there is insufficient space for at least two text lines. The captions should be as normal text, i.e., only the first letter should be capitalized and must be centered. The caption format should follow 1.5 Line spacing Before 24 pt and After 12 pt. There should be no blank lines before or after the Algorithm Caption. There should be one blank line (Line spacing: 1.5 Lines) after the Algorithm box. Algorithms must also be separated 1 cm from left and right margins and limited within a frame. Author can use the font type, font size and text color of the original source code within this frame.

Algorithm 3.1. Core training algorithm

|  |
| --- |
| wi=0 ∀1 ≤ i ≤ t ***coreTraining(*C**mxn***)*****for** i **from** 1 **to** m **for** j **from** 1 **to** m (p0,p1)=***Z***(***K***(**c(i,:)**),***K***(**c(j,:)**)) $f\_{ij}$=p0 **∙**p1 **end for****end for****xm**=***mult***(**Fmxm**, **bm**) where **bm**$=\left\{\begin{array}{c}b\_{i}=1, \&∀1 \leq i \leq m/2\\b\_{i}=-1, \&∀m/2+1\leq i \leq m\end{array}\right.$**for** i **from** 1 **to** m **wn+1**=***av***(**wn**,***mult***(***K***(**c(i,:)**),xim))**end for****return** **wn+1** |

Algorithms should be enumerated within each chapter, i.e., as 2.1, 2.2, 2.3, 3.1, 3.2, etc. The designation of each table or figure within the text should have only the first letter in the capital (i.e., such as "Algorithm 3.1") throughout the thesis. Captions of algorithms should be centered, as shown in the example. The captions should be as normal text, i.e., only the first letter should be capitalized. The captions should be at a distance similar to those described in table captions.

## APPENDICES

A last section may contain supporting data for the text in one or more appendices. Examples of appendix material include data sheets, questionnaire samples, flowcharts, illustrations, maps, software listings, charts, etc. if the appended data should include oversized illustrations or maps, several alternative methods of inclusions are available. If an ethical approval form is available for the study presented in the thesis, a scanned copy of the form with original signatures on it must be presented in the Appendix, e.g., APPENDIX A: ETHICAL APPROVAL FORM.

If a section, table, figure, equation, etc., is to be included in an appendix, the numbering should follow the same rules used within the thesis. In this case, however, they should begin with the letter of the respective appendix such as "Table A.l", "Equation (B.4)" etc. The title should start with the left-justified appendix title such as "APPENDIX A: " and then followed by the descriptive title (See Page 17).

This page intentionally uses landscape.

Note that the page margins and the page numbering location are different here.

# PREPARATION OF THE FINAL COPIES

After the main heading, it is required that a short description text is given before the next subheading.

## TYPESETTING

Word processing software such as MS Office WORD and Open Office WRITER is highly recommended. TEX or LATEX is also acceptable on the condition that accomplishes the format rules discussed in this document.

## PAPER QUALITY

The original copy shall be typed on 75 or 80 gr/m2 A4-size white paper. All reproduced copies should be of the same grade of paper.

## PRINTER

Only laser printer and Ink Jet printer outputs are acceptable. Printer settings must comply with A4-size paper and must be so that the page is not resized in printing.

## BINDING

The thesis should be bound in dark blue hardcover and in black hardcover for M.Sc. and Ph.D. respectively. The final bound size of the thesis should conform to the A4 size. The name and surname of the candidate, the type of degree obtained and the year should be printed in the above order on the spine of the cover. When the thesis is placed front cover-up, the spine should read from left to right.

# PUBLICATION OF THESIS

After the main heading, it is required that a short description text is given before the next subheading.

## USE OF COPYRIGHTED MATERIAL

Writers of the thesis must assume full responsibility for use of any copyrighted material in their manuscripts. The written permission of the copyright owner must be obtained when extensive use is contemplated.

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NUMERICAL EXAMPLE FOR RT-CAMKD

A={a1, a2, a3, a4, a5} where a1, a2, a3, a4 and a5 correspond to*drinking*, *eating*, *pouring*, *toothBrushing* and *turningKey* respectively. Let’s assume that Ta={M12x3}$∀a\in A$ and M12x3 =$\left[\begin{matrix}-46&3&8\\-46&3&8\end{matrix}\right]$ for a=a1. (We are demonstrating the operations only on a1 since operations on other simple actions are handled in a similar way.) To generate the pattern for a1, we start from the ***training*** algorithm:$ P\_{a\_{1}}^{1x5}\leftarrow $***featureExtraction***(M12x3|a=a1)

Then execution swiches to ***featureExtraction*** module: C2x3=$\left[\begin{matrix}-46&3&8\\-46&3&8\end{matrix}\right]$and m=2 and n=3, R2x3=$\left[\begin{matrix}1&1&1\\1&1&1\end{matrix}\right]$, d(1,:)=***K***((-46 3 8)), d(2,:)=***K***((-46 3 8)), d(3,:)=***K***((1 1 1)), d(4,:)=***K***((1 1 1)). Taking e=2.72 and using the ***K*** function: d14= $\frac{1}{1+2.72^{-46}}$ + $ \frac{1}{1+2.72^{3}}$ + $ \frac{1}{1+2.72^{8}}$ =1.047, di4$ ∀2\leq i\leq 4 $are calculated as d14, yielding D4x4=$\left[\begin{matrix}-46.000&3.000&8.000&1.047\\-46.000&3.000&8.000&1.047\\1.000&1.000&1.000&0.806\\1.000&1.000&1.000&0.806\end{matrix}\right]$ where 2m=4 and n+1=4.

DETECTED ACTIVITIES IN T1P1 TESTS

Table B.1 to Table B.2 illustrate detected activities in T1P1 tests. For a more concise presentation, *toothBrushing* and *turningKey* actions are abbreviated as tB and tK, respectively, within the tables. testId shows the number of the test, action names given in the column names indicate the actual type of action whereas action names within the table entries show detected activity results corresponding to the actual activity whose type is specified by the related column name. Therefore, when a table entry matches the related column name, it means a successful detection. The composite action tests incorporate several columns named chunk\_2, chunk\_4, and chunk\_6, which represent the first, second, and third transitions, respectively. Since transition type is inferred considering the simple actions right before and after the transition, the types detected for them are ignored.

Table B.1. Drinking

|  |  |
| --- | --- |
| **testId** | **drinking** |
| 1 | drinking |
| 2 | drinking |
| 3 | drinking |
| 4 | drinking |
| 5 | drinking |
| 6 | drinking |
| 7 | drinking |
| 8 | drinking |
| 9 | drinking |
| 10 | drinking |

Table B.2. Drinking pouring behavior of the hypothetical sample of the monuments and official antiquities.

|  |  |  |  |
| --- | --- | --- | --- |
| **testId** | **drinking** | **chunk\_2** | **pouring** |
| 1 | drinking | pouring | pouring |
| 2 | drinking | pouring | pouring |
| 3 | drinking | pouring | pouring |
| 4 | drinking | pouring | tB |
| 5 | drinking | pouring | tB |
| 6 | drinking | pouring | pouring |
| 7 | drinking | pouring | pouring |
| 8 | drinking | pouring | tB |
| 9 | drinking | pouring | pouring |
| 10 | drinking | pouring | tB |

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