

THESIS TITLE IN ENGLISH

NAME SURNAME

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF
BACHELOR OF ENGINEERING IN ROBOTICS AND AI ENGINEERING
SCHOOL OF ENGINEERING
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
20XX
KMITL-20XX-EN-X-XXX-XXX

| | |
|--------------------------|------------------------------------|
| Thesis | Thesis Title in English |
| Student | Mr. Name Surname |
| Student ID. | XXXXXXXX |
| Degree | Bachelor of Engineering |
| Program | Robotics and AI Engineering |
| Year | 20XX |
| Thesis Advisor | Prof. Dr. Thesis Advisor |
| Co-Thesis Advisor | Assoc. Prof. Dr. Co-Thesis Advisor |

ABSTRACT IN ENGLISH

A good abstract writing should focus only on the key and interesting aspects of the research. It should emphasize the specific highlights of the research, with the research work being clear, concise, and meeting certain criteria for a good abstract. For example, the word count should be between 200-250 words, or approximately no more than half of an A4 page. Before writing the abstract, one should read and understand their own complete research work to identify various interesting points that can engage general readers, making them want to read the full research. There should be no interpretation or criticism using personal opinions. Complex or aggressive language should be avoided. Local jargon, unnecessary abbreviations, or symbols should not be used as they may lead to misunderstanding. There should be no numerical references, diagrams, tables, various statistical formulas, or equations in the abstract, unless necessary to display analytical results. The abstract may have multiple paragraphs to enhance reader comprehension in each section. Avoid referencing the research work of others in the abstract. The structure of the abstract should also be carefully considered, including font type, font size, page margin, printing standards, and an acceptable format. Proofreading the writing by reading it multiple times will improve the quality of the abstract, making it acceptable for research presentations.

ACKNOWLEDGEMENT

Acknowledgement refers to an announcement of appreciation for virtue. It specifically acknowledges the goodness of individuals who provided assistance leading to the successful completion of research, a thesis, or an academic report. During the process of conducting research, a thesis, or academic work, individuals may receive assistance, guidance, or support that contributes to the successful completion of the task. In recognition of this aid and in gratitude, individuals express their appreciation by writing a Certificate of Appreciation, which is included at the beginning of the research, thesis, or academic work. This serves to demonstrate satisfaction and heartfelt gratitude for the goodness of those who assisted. In essence, a Certificate of Appreciation is a declaration of gratitude.

Name Surname

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LIST OF ABBREVIATIONS AND SYMBOLS

| | |
|---|---------------|
| C | Specific heat |
| P | Pressure |
| V | Volume |

CHAPTER 1

INTRODUCTION

1.1 SIGNIFICANCE OF A THESIS

A thesis is a continuous presentation of a study or research undertaken by students or researchers. Research or study at the graduate level differs significantly from undergraduate study because it involves in-depth exploration, problem identification, and a well-defined problem-solving process. It presents reasoned theories, analysis, and logically sound critiques from various perspectives. Therefore, a thesis is a written work or literature that must be studied, referenced, or further researched by subsequent students or researchers. A good thesis should have the following characteristics:

- 1) It should address a specific research question or problem.
- 2) It should demonstrate a thorough understanding of the relevant literature.
- 3) It should employ appropriate research methodologies.
- 4) It should present original findings or contributions to the field.
- 5) It should be well-organized and clearly written.

1.2 THE IMPORTANCE OF THE THESIS PRESENTATION PROCESS

The sequence of steps in presenting or writing a thesis is of paramount importance for the understanding of the readers, whether they are the thesis examiners themselves or individuals who will use the thesis for research or reference in subsequent ranks. The central content of the thesis should ideally consist of three main subsections: the introduction, the main content section, and the conclusion.

1.2.1 Introduction Section

The introduction section serves as the first chapter of the thesis, following the abstract. Many theses have a distinct separation between the abstract and the introduction. The abstract provides a concise overview of what the problem is, what the author has done, how it was done, and what the outcomes were. The introduction, on the other hand, leads the reader into the problem systematically. It often summarizes previous research in the field and then explicitly identifies the clear problem (problem identification) that the author will address or solve, followed by outlining the study or problem-solving process. This leads to the transition into the second section, which is the main content section.

1.2.2 Main Content Section

The main content section of the thesis is the largest part of the entire document. It typically comprises several chapters, ranging from 2 to 5 chapters or more, with each chapter having a similar length and content. Each chapter should not be overly long to ensure readability (usually around 20-40 pages). The first chapter in this section often discusses general principles or relevant theories and the research conducted by others (literature review). Subsequent chapters detail various stages of the study or problem-solving process, along with the results obtained. Many theses in this section conclude each chapter and provide an introduction to the next

chapter.

1.2.3 Conclusion Section

This section of the thesis is crucial and consists of no fewer than the first two sections. It demonstrates the achievement of the study's objectives and showcases the depth of the researcher's understanding. It involves presenting analysis, critique, or recommendations. The conclusion section and the summary section should be clearly distinguished because the conclusion typically provides a concise overview of the study or research results.

1.3 LANGUAGE

In thesis writing, the author can write in either Thai or English. The language used for presenting the thesis is written language, not spoken language, and it is not about quantity but quality. Therefore, each page of the thesis must be concise, clear, and adhere to the principles of correct vocabulary and grammar usage. The use of technical terminology or foreign language words should also be considered. If possible, use translated terms or standard vocabulary in the Thai language (if the thesis is written in Thai). If unsure about conveying the meaning correctly, include the foreign language term in parentheses. It is essential to understand that the language used in thesis writing is a means of mutual understanding between the author and the readers of that thesis. In addition to using the correct words, the order of words presented is equally important. Each paragraph should clearly indicate its main point, and the transitions between adjacent paragraphs should serve as a good bridge for readers to follow seamlessly. Redundancy, misleading statements, and ambiguity should be avoided in thesis writing. Typically, authors do not intend for these issues to arise, but they often occur due to lack of carefulness. Some sentences or paragraphs may appear non-repetitive at first glance but summarizing them may reveal that they reiterate the same points made previously. Such repetition can lead to confusion. Always keep in mind that a paragraph or sentence should be summarizable, and readers should not conclude that the author is saying something different than what was previously stated. This thesis guide provides details on various aspects of thesis writing that authors should be aware of and adhere to the institute's regulations. In Chapter 1, the importance of the thesis, its different parts, and the language used in thesis writing are discussed. Chapter 2 provides details and formats for various parts of the thesis, starting from the cover page. Chapter 3 elaborates on the format of paper size, printing standards, and an acceptable format. The methods of referencing and writing bibliography and citations are discussed in Chapters 4 and 5, respectively. Appendices are divided into three main sections: the process of proposing a thesis and requesting thesis examination, various examples of thesis writing, the institute's regulations regarding graduate studies, and related form templates.

CHAPTER 2

THESIS ORGANIZATION AND COMPONENTS

2.1 THESIS COMPONENTS - PART 1: PRELIMINARY SECTION

This section includes:

1. COVER PAGE
2. ENGLISH TITLE PAGE
3. COPYRIGHT PAGE
4. APPROVAL SHEET
5. THAI ABSTRACT
6. ENGLISH ABSTRACT
7. ACKNOWLEDGEMENT
8. TABLE OF CONTENTS
9. LIST OF TABLES (if any)
10. LIST OF ILLUSTRATION OR FIGURES (if any)

2.2 THESIS COMPONENTS - PART 2: MAIN SECTION

This section includes:

1. Introduction
2. Main Content, which may consist of:
 - 2.1 Literature Review (or related research) (LITERATURE REVIEW)
 - 2.2 Research Methodology (RESEARCH METHODOLOGY), which may have multiple chapters
 - 2.3 Experimental Results or Data Analysis (RESULTS OR ANALYSIS OF DATA)
 - 2.4 Critique or Discussion of Findings (DISCUSSION)
3. Conclusion, which may include:
 - 3.1 Research Summary and Recommendations (CONCLUSION AND SUGGESTION)

2.3 THESIS COMPONENTS - PART 3: FINAL SECTION

This section includes:

1. BIBLIOGRAPHY OR REFERENCES (if any)
2. APPENDIX, APPENDICES (if any)
3. AUTHOR BIOGRAPHY

2.4 EXPLANATION OF THESIS COMPONENTS

2.4.1 Part 1: Preliminary Section

- 1) COVER

The top section includes the thesis title in English, separated by one line.

The middle section includes the author's name in English, without using any prefixes such as Mr., Mrs., Miss, etc.

The bottom section includes the statement:

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF...
OF ENGINEERING IN ...
SCHOOL OF ENGINEERING
KING MONGKUT'S INSTITUTE OF TECHNOLOGY LADKRABANG
20XX (year of thesis submission)
KMITL-20XX-EN-X-XXX-XXX

Note

- a) For study programs that require coursework (Plan 1.2), use the phrase:

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF...

- b) For study programs that do not require coursework but focus solely on research (Plan 1.1), use the phrase:

A THESIS SUBMITTED IN FULFILLMENT
OF THE REQUIREMENT FOR THE DEGREE OF...

- 2) ENGLISH TITLE PAGE The content is the same as the cover in all respects.
- 3) COPYRIGHT PAGE Print on the left-bottom margin of the page in English.
- 4) APPROVAL SHEET The graduate affair issues the approval sheet. The Dean of the School of Engineering signs the approval sheet upon successful defense.
- 5) THAI ABSTRACT Include the thesis title, student's name, student ID, degree name, department name, year of thesis publication, thesis advisor's name, and co-advisor's name (if applicable).
- 6) ENGLISH ABSTRACT Follow the same format and content as the Thai abstract.

Note: The thesis should be written in both Thai and English, and both versions should have abstracts.

- 7) ACKNOWLEDGEMENT Express gratitude to individuals who contributed to the successful completion of the thesis, including the thesis advisor and sources of funding (if applicable).
- 8) TABLE OF CONTENTS List the page numbers in Roman numerals (I, II, III, IV...) for the abstract, introduction, and all the way to the last page.
- 9) LIST OF TABLES List the page numbers for tables in sequential order, including tables in the appendices.
- 10) LIST OF ILLUSTRATIONS OR FIGURES List the page numbers for illustrations, maps, graphs, etc., in sequential order, including those in the thesis appendices.

2.4.2 Part 2: Main Section

2.4.2.1 Introduction

The introduction, which is Chapter 1, serves as the beginning of the main content. It may include the following:

1) STATEMENT AND SIGNIFICANCE OF THE PROBLEMS

Discuss the background and significance of the research topic. Explain why this topic is being investigated, what problems are of interest in the research, what benefits the research can provide, and how it will contribute to the overall understanding.

2) GOAL AND OBJECTIVE OF THE STUDY

Clearly state the goal and objectives of the study, specifying what the study aims to prove or discover.

3) HYPOTHESIS

Present the hypotheses that will be tested in the study, based on the research objectives and referencing relevant principles and theories.

4) SCOPE OF THE STUDY

Define the scope of the study by specifying what the study will cover and how broad or limited it is.

5) PROCESS OF THE STUDY

Summarize the steps or processes involved in conducting the study.

6) ASSUMPTIONS

State any preliminary assumptions or conditions that apply to the study.

7) LIMITATION OF THE STUDY

Identify any constraints or variables that cannot be controlled, such as time limitations, budget constraints, or other factors.

8) DEFINITIONS

Provide definitions for terms or concepts that are specific to the study. Technical terms and abbreviations may be compiled in a list and included in or after the table of contents. This chapter sets the stage for the research, providing readers with a clear understanding of the background, goals, and parameters of the study.

2.4.2.2 Main Content

1) Literature Review

The literature review discusses existing theories, ideas, literature, or research related to the study. It serves as a guide to the research process, highlighting previous work that is relevant and significant to the current study.

2) Research Methodology

The research methodology section provides details on the following:

- **Research Methods:** Specify the research methods employed, such as document analysis, surveys, or experiments.
- **Data Characteristics and Selection:** Explain the nature of the data used and the rationale for selecting specific data sources.
- **Tools and Techniques:** Describe the tools and techniques used in data collection and analysis.
- **Data Collection Procedures:** Outline the steps taken to gather data.
- **Data Analysis Methods:** Explain the methods used to analyze the data, which may include statistical techniques.

3) Results or Analysis of Data

This section presents the detailed results of the study, including tables and figures if applicable. Statistical analysis may be used to provide clear interpretations of the data.

4) Discussion

The discussion section serves several purposes:

- To highlight the underlying principles demonstrated by the study.
- To support or challenge previously proposed theories.
- To compare the study's results with those of others.
- To summarize key findings and implications of the research.

The author should emphasize critical issues or controversies related to the main content and offer recommendations for future research.

5) Tables and Figures (if applicable)

Tables and figures should be integrated into each chapter of the main body where relevant.

2.4.2.3 Conclusion

The conclusion and suggestions section is the final chapter. It summarizes the research findings, starting from the research inception through the completion of the study. It highlights the significance of the work, the key results obtained, and provides an analysis of the overall research process.

Suggestions refer to recommendations or insights that can enhance the research, focusing on areas for improvement or further analysis within the research work. It aims to suggest ways to enhance efficiency, accuracy, or comprehensiveness to maximize the value and utility of the research for future users and researchers.

2.4.3 Part 3: Final Section

2.4.3.1 Reference List

In the concluding section of your thesis, you should provide a reference list that includes all the sources you cited in your thesis. You have the option to use either a bibliography or a references section, but you should stick to one method consistently throughout your thesis.

Bibliography: This is a list of books, documents, or other media that you consulted while conducting your research, presented in a name-year format within the body of your thesis.

References: This is a list of sources cited in your thesis, presented in a numbered format, typically following a specific citation style like APA, MLA, Chicago, or any other style relevant to your field.

2.4.3.2 Appendices (if applicable)

The appendices section is meant to provide additional information that can help readers gain a more detailed understanding of your thesis content. It may include items such as interviews, questionnaires, research timeframes, budget details, related research publications, or any other relevant data. You can have multiple appendices if needed, and they should be labeled as Appendix A, Appendix B, Appendix C, and so on.

2.4.3.3 Author Biography

The author biography section provides information about the author's background and qualifications. It typically includes the author's full name, date and place of birth, educational qualifications (including

degrees, institutions, and graduation years), academic achievements, awards, scholarships, current affiliation, work experience, and current position or role. This section helps readers understand the author's expertise and credibility in the subject matter of the thesis.

CHAPTER 3

PAGE LAYOUT

The students must study the requirements and formatting for their theses according to the thesis guidelines of the graduate studies in order to ensure that the paper outline meets the standard. Prior to the final thesis defense presentation, students are required to submit the original version to their thesis advisor for review to ensure accuracy and uniformity.

3.1 PAPER SIZE

The paper used for printing the thesis content must be white, unlined, A4 size paper (210 mm wide and 297 mm long).

3.2 FONT

For the thesis cover, use 20-point font size for the title in Thai (approximately 3 mm in height) and 18-point font size for the title in English (approximately 2.5 mm in height). Use the TH Sarabun New font style. The font size for the inside cover should be the same as the outside cover.

The font size for the chapter titles, section headings, and content can be found in the following section.

3.3 LINE SPACING

Use a 7-character word space, which is approximately 60 characters per line. Please indent the first line of each paragraph.

3.4 MARGINS

The top margin should be 1 inch (25.4 mm) from the paper's edge.

The left margin should be 1.5 inches (38.1 mm) from the paper's edge.

The right margin should be 1 inch (25.4 mm) from the paper's edge.

The bottom margin should be 1 inch (25.4 mm) from the paper's edge.

3.5 PAGE NUMBERING

For Part 1, starting from the abstract to the bibliography (if present), use Roman numerals (I, II, III, IV, V) to indicate page numbers. Print them at the bottom center of each page.

For the main content section, use Arabic numerals 1, 2, 3, 4, 5 to indicate page numbers. Print them at the top right, 0.5 inches from the top edge of the paper, and 1 inch from the outer edge of the paper.

The first page of each chapter does not need a page number, but the pages should be counted.

3.6 CHAPTER DIVISION, MAIN HEADINGS, AND SUBHEADINGS

Chapter numbers, such as Chapter 4, should be centered on the page and in bold with a 20-point font size.

The chapter title should be printed in the center of the page, in bold with a 24-point font size. No chapter numbering is required.

Major headings, which are titles other than the chapter title, should be aligned to the left margin, followed by a chapter number and a period (.), and then the heading number. Use bold 18-point font size and leave a 1-line space above.

Subheadings, which divide the major headings, should be indented from the left margin by 7 spaces. Use the number of the major heading, followed by a period (.), and then the subheading number. Leave a 2-space gap and then use a bold 16-point font size. Leave a 1/2-line space above.

| | |
|--|--|
| 1.1 Major Heading | |
| 1.1.1 Sub heading of 1.1 | |
| 1.1.1.1 Sub Heading of 1.1.1 | |
| 1) Sub Heading of 1.1.1.1 | |

For any section headings, capitalize the first letter of each word. The first letter of each word in major headings and subheadings must be capitalized.

Use black Thai Sarabun New font style with a 16-point font size (approximately 2 mm in height) for the content text. Maintain the same font style throughout the document for symbols or characters that the printer does not provide. Use black ink, preferably of high quality.

3.7 TABLES

Insert tables within the relevant sections of the main text, leaving one line space before printing the word "Table" followed by the table number in bold, aligned to the left margin. Then, print the table name. If the table name is longer than one line, print the top line longer than the bottom line, starting in line with the first letter of the table name. Continue the table without leaving a line if needed. If a table is too wide to fit on one page and must be continued on the next page, align it to the left margin and print the word "(continued)" followed by the table number, like "Table 3.1". After finishing the table, leave one line space before the next regular text.

(Leave one line space)

| Spacing | | Modulus % | | | | |
|---------------------|---------------------|--------------------|--------------------|--------------------|--------------------|---------------------|
| S ₁ (cm) | S ₂ (cm) | 0 | 30 | 50 | 80 | 100 |
| 3.3 | 7.5 | 49 cm ² | 64 cm ² | 81 cm ² | 85 cm ² | 90 cm ² |
| 3.8 | 8.5 | 60 cm ² | 75 cm ² | 90 cm ² | 97 cm ² | 100 cm ² |
| 4.3 | 9.5 | 70 cm ² | 81 cm ² | 95 cm ² | 99 cm ² | 109 cm ² |
| 4.8 | 10.5 | - | - | - | - | - |

Table 3.1: Example of Table

(Leave one line space)

3.8 IMAGES

To insert images, leave one line space before placing the image in the center of the page. Include the words "Picture." or "Figure" (use either one consistently throughout the document), followed by the image number, using bold font. The image description should not exceed one line and should be placed in the center beneath the image. If the description extends beyond one line, place it on the left edge. Number the images or pictures in a manner similar to how tables are numbered, following the end of the image description. Leave one line space before continuing with regular text.

(Leave one line space)

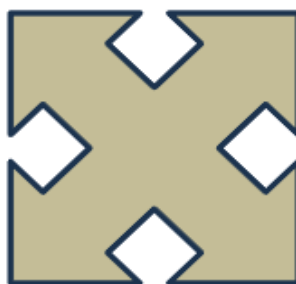


Figure 3.1: Example of Figure

(Leave one line space)

3.9 TABLE OF CONTENTS, TABLE OF TABLES, TABLE OF FIGURES (OR LIST OF FIGURES)

Print the words "Table of Contents," "Table of Tables," "Table of Figures" (or "List of Figures") in the center of the page, 1 inch from the top margin, using 24-point bold font.

Leave one line space and then print the word "Page" aligned to the right. Print the page numbers flush with the right margin and connect them to the content with dots.

Next, after one line space, will be the content of the table of contents, between different chapters, bibliography, and appendices. Leave one line space. As for the Table of Tables and Table of Figures (or List of Figures), print the words "Table #" or "Figure #" aligned to the left margin, on the same line as "Page."

3.10 ABBREVIATION LIST OR SYMBOL LIST

Use this for cases when the abbreviation list is printed separately from the introduction and follows the instructions in section 4.10. Print the words "Abbreviation List" or "Symbol List" (or "Abbreviation and Symbol List") in the center of the page, 1 inch from the top margin, using 24-point bold font.

Leave one line space, and then start printing the abbreviations or symbols flush with the left margin. If the description of the abbreviation or symbol doesn't fit on one line, start the next line from the 8th character, as before.

For English letters, Greek letters, and symbols with upper/lower marks and numeric marks:

English Letters: A, B, C, b, c Greek Letters: C, P, Y,...

If there are English letters mixed with Greek letters, the Greek letters come after the English letters. Symbols with Upper/Lower Marks and Numeric Marks: $A_1 A_x A^1 A^x A_1^x a_1 a_x a^1 a^x a_1^x$

In this order, symbols with lower marks come before symbols with upper marks. Additionally, symbols with numeric marks come before symbols with alphabetic marks.

3.11 SCIENTIFIC NAMES

For biological organisms, plants, and animals, use the International Code of Nomenclature for emphasizing scientific names. Make them stand out distinctly from other text by underlining or using italics. Scientific names follow the binomial system, consisting of two parts. The first part is the Genus name, which begins with an uppercase letter, and the second part is the Specific epithet, written slightly offset and beginning with a lowercase letter. In scientific names, it's common to include the name of the person who initially defined the name and described the organism. Personal names are typically used for surnames only. If it's a well-known name, it may be abbreviated, such as Linnaeus abbreviated as "Linn." or "L." In some cases, when two individuals co-author a name, both names are used, for example...

- | | |
|-------------------|---|
| a. micro-organism | Escherichia coli, Bacillus subtilis, Azospirillum brasilense |
| b. plant | Coccinia grandis L., Canna indica Linn., Cocos nucifera Linn. |
| c. animal | Ptilolaemus tickeli, Panthera tigris |

3.12 MATHEMATICAL EQUATIONS

Mathematical equations can be inserted into the text. To maintain order, separate equations on their own lines. Equations should be positioned with a one-line space above and below. Equations should be centered on the page as appropriate and use the Cambria Math font with a font size of 11 points.

Enclose equation numbers in brackets, and order equation numbers in the same way as tables and images, for example...

$$S.D. = \sqrt{\frac{\sum (x - \bar{x})^2}{N - 1}} \quad (3.1)$$

3.13 FOREIGN LANGUAGES

For words in foreign languages, print a translation in English within parentheses following the necessary terms. For example, Technique (เทคนิค). Printing foreign languages without diacritical marks is common. For instance, "เทคโนโลยี" should be printed as "Technology" Compound words should not use "ส" or "ส์" in Thai. For example, "Games" should be printed as "เกม," except for proper names like "SEAGAMES," which should be printed as "ซีเกมส์."

3.14 ABBREVIATIONS

b&w (black and white) means black and white images.

c. (copyright) means used for copyright year.

ca. (circa) means an approximate date.

ch. (chapter) means chapters in royal decrees, laws, etc.

chap. (chapter) means regular chapters; use "chaps." for plural.

col. (color) means color photographs.

ed. (edition ; editor ; edited by) means editor or edited by.

enl. (enlarged) means an enlarged edition, e.g., "enl. ed."

et al. (et alii) means and others.

fig. (figure) means figures, plural "figs."

fr. (frame) means frame in slides to indicate the number of frames.

i.p.s. (inches per second) means inches per second in tape speed.

ill. (illustrated by) means illustrated by.

min. (minutes) means film duration in minutes.

ms. (manuscript) means manuscript, plural "mss."

n.p. (no place; no place of publishing) means no place of publication.

no. (number) means number, plural "nos."

2nd. ed. (second edition) means the second edition.

p. (page) means page, plural "pp."

Par. (paragraph) means paragraph, plural "pars."

Pt. (part) means part, plural "pts."

r.p.m. (revolutions per minute) means revolutions per minute.

rev. (revised) means revised edition, e.g., "rev. ed."

3rd ed. (third edition) means the third edition.

sc. (scene) means scene.

sd. (sound) means sound in films.

sec. (section) means section, plural "secs."

Si. (silent) means silent films.

trans. (translator; translated by) means "translator" or "translated by".

Vol. (volume) means volume, plural "vols."

3.15 PUNCTUATION MARKS

Period (.) should be printed with a 2-space gap between words.

Comma (,) should be printed with a 1-space gap between words.

Semicolon (;) should be printed with a 1-space gap between words.

Colon (:) should be printed with a 1-space gap between words.

Quotation marks (" ") should be printed with a 1-space gap between words.

CHAPTER 4

REFERENCE AND CITATION

Citation refers to the reference documents used in thesis writing. It is a way to inform the sources of the text, ideas, or any content that is not originally created by the author. This is done as a tribute to individuals or organizations who own the intellectual property of the ideas or the data. It also serves the convenience of readers who wish to know more details from the original source to be able to trace accurately. Citations can either summarize the original content or can be a direct quotation, maintaining the original writing format. To ensure accuracy, all information in the reference list must be precise and thoroughly checked for their sources.

Citations come in two main formats:

In-text citation using the name-year system.

In-text citation using the numerical sequence system.

At the end of the thesis, all the documents and references cited can be organized alphabetically according to the authors' names in a **bibliography** or in numerical order according to the reference numbers in a **reference** list.

4.1 IN-TEXT CITATION IN THE NAME-YEAR SYSTEM

Citations should include the author's name and the publication year, with the option to include page numbers separated by a colon (:).

Author names in Thai documents should include both first and last names, while in foreign language documents, only the last name should be used.

The citation format may vary depending on the sentence structure, either placed at the beginning or end of a sentence.

Example (Author mentioned at the beginning of the sentence):

Suttalak Ampanswong (2521: 25) explains that information refers to various knowledge, news, and data.

Good (1973: 112) defines commitment as an individual's expression of love and concern.

Example (Author mentioned at the end of the sentence):

...managers must have the ability to manage people to foster cooperation and collaboration in responsive and well-coordinated work, leading to the efficient achievement of organizational objectives (Uthai Boonprasert, 2531: 23).

In citations, there may be different cases as follows:

1. Single Author

Mayuree Chaisawat (2538: 86)...

Heyes (1964)...

2. Two Authors

Prayad Jantachomphu and Prasopas Aksonmat (2518: 24)...

Macaulay and Berkowitz (1978: 4)...

3. More than Two Authors

Sanan Jittrasuk et al. (2532: 21-25)...

Bradley, S. et al. (1983: 23-25)...

4. Authors from an Institution, Organization, Corporation, or Agency

From the meeting of education institution managers under the Department of Vocational Education (Department of Vocational Education, 2531) on the topic "Human Resource Needs."

...and environmental pollution, termed as 'air pollution' or the occurrence of air pollution (Department of Environmental Quality Promotion, 2539: 118).

5. Multiple Titles by the Same Author in the Same Year

Sutthas Yaksan (2529a)...

Heyes (1964c)...

6. Multiple Citations within the Same Topic from Multiple Sources

...(Yawonuch Sengyont, 2525a; Supada Intranukul, 2525)...

...(Kartner, 1973; Kartner and Russel, 1975)...

7. No Author Identified

Use 'Anonymous'

Anonymous (1973)...

8. Quotations Longer Than 3 Lines

Should be separated from the main text with a one-line space above and below. The left and right margins of both sides should be indented 8 character spaces, followed by the name-year citation in parentheses, without quotation marks ("").

Example:

...The personnel in the organization are the heart of the organization, a vital force that propels the organization forward. As Somyasit Naweeakarn stated,

(Leave 1 line blank)

'Internal conflicts within an organization can be designed or managed in various ways. Conflicts can yield positive and negative results. The positive aspect is that conflicts lead to the exploration of better outcomes, making the organization operate more efficiently. However, if conflicts are excessive, they can negatively impact the personnel in the organization and impede the achievement of the organization's goals' (Somyasit Naweeakarn, 2530: 15).

9. Electronic Information and Communication

For electronic sources such as CD-ROM, Internet, use the previously mentioned citation methods.

4.2 IN-TEXT CITATION IN THE NUMERICAL SEQUENCE SYSTEM

In this referencing system, citations are numbered sequentially in the order they appear in the text, starting from the first chapter to the last. The reference numbers are enclosed in square brackets at the end of the relevant text. If a reference is repeated, the same number is used.

Example:

Due to the necessity of frequency-based decoding, various transformations must be applied, including essential conversions [1]. Apart from other computations, the prime factor algorithm is employed for

decoding, reducing the computational load when combined with the Short Length Algorithm [2]. In practical implementation, the application of these methods requires careful consideration...

Alternatively, Berlekamp's technique has the capability to generate both polynomials [2] . However, the process becomes more intricate in the presence of erasures. Blahut [3] has detailed the procedure for obtaining the error-erasure locator polynomial. This involves initializing the error locator polynomial with the erasure locator polynomial. He has also demonstrated that the error evaluator polynomial and the derivative of the error locator polynomial can be iterated within those $2t$ iterations [4].

CHAPTER 5

BIBLIOGRAPHY AND REFERENCES

The writing of a bibliography or references should adhere to one system that aligns with the chosen citation method. Use 'Bibliography' when citing in-text with the name-year system and use 'References' when citing in-text with the numerical sequence system. The use of bibliography management software, such as Endnote, Mendeley, Zotero, etc., is permitted and encouraged.

5.1 GUIDELINES FOR WRITING BIBLIOGRAPHY

1. Print the word Bibliography in the center of the page in bold, size 24 points.
2. Arrange the entire reference list together, alphabetically based on the first letter of each reference, following the alphabetical order as per the dictionary.
3. For theses written in Thai, list the bibliography in the Thai language first, followed by the English language bibliography. For theses written in English, list the English language bibliography first, followed by the Thai language bibliography.
4. Begin printing the bibliography at the left edge of the paper. If the entry does not fit on one line, start a new line indented by 7-character spaces. Begin printing the 8th character if the entry extends to the second line. If not completed within two lines, continue onto lines 3-4 starting from the same position as line 2 until the end of the entry. When starting a new entry, align it with the left edge of the paper without skipping a line.

5.2 GUIDELINES FOR WRITING REFERENCES

1. Print the word References in the center of the page in bold, size 24 points.
2. Arrange the reference documents in numerical order, according to the numbers assigned within parentheses referring to the content of the thesis.
3. There is no need to separate by language or document type.
4. Print the number of each entry at the left edge of the paper. If the entry does not fit on one line, start a new line indented by 7-character spaces. Begin printing the 8th character if the entry extends to the second line. When starting a new entry, align it with the left edge of the paper without skipping a line.

5.3 METHOD OF LISTING BIBLIOGRAPHY

5.3.1 Authors

1. The author's name should not include any titles such as Mr., Mrs., Miss, Dr., etc.
2. For entries in the Thai language, use the author's first name followed by the last name.
3. For entries in English, use the last name, followed by a comma and the abbreviated first and middle names in sequence.
4. If the author holds a doctorate (Ph.D.), professorship, or other title, include it after the name, separated by a comma.

5. Use the name as it appears in the document for authors with honorific titles.
6. If there are two authors, use the name of the first author followed by and between the names of the two authors.
7. If there are more than two authors, list all authors.
8. For authors using pseudonyms, use the pseudonym as it appears in the document.
9. For translated documents, list the name of the translator first, followed by the phrase "translated from" and the original author's name. If the original title is unknown, use the phrase "translated by" or "translated and compiled by."
10. For documents attributed to an organization, ministry, or department, use the name of the organization as the author. In the case of documents issued under a specific department within a ministry or subordinate to a department, even if the ministry's name is mentioned, use the department's name as the author. Include the name of the subordinate unit in the publisher section.
11. For documents with only an editor or compiler, use the editor's name followed by a comma and the word editor or compiler after the name of the author.
12. For documents with no stated author or conference proceedings, use the title of the document as the first entry.

5.3.2 Article Titles

1. Use the title as it appears in the document, enclosed in quotation marks.
2. For English titles, capitalize the initial letter of each word, except for conjunctions, articles, and prepositions, unless they are the first word.
3. If there is a scientific name in Latin for plants, animals, etc., insert it in *italics* or underline it.

5.3.3 Book or Journal Titles

1. Print book or journal titles in bold.
2. For international journals, you may use the correct abbreviation of the journal name.
3. For book series, if referencing a specific volume, include only that volume. For example, if referring to volume 3, and if citing multiple non-consecutive volumes, indicate each volume number with commas in between, such as Volume 1, 3, 5. If citing all volumes in the series, state the total number of volumes, such as 5 volumes or 5 vol. Underline or print in bold (either one) continuously from the title.

5.3.4 Editions

1. For the first edition or first printing, it is not necessary to specify in the bibliography.
2. Specify the edition number for subsequent editions, as indicated in the printed material. For example, 2nd Ed., 2nd printing, 2nd, rev. ed., or 2nd, expanded ed.

5.3.5 Place of Publication and Publisher

1. For Thai-language references, include the name of the province as the place of publication. For Bangkok, use the term Bangkok.
2. If the publisher has offices in multiple cities and the names of those cities appear in the document, use the first city mentioned as the place of publication.

3. List the publisher's name without including terms like Publisher, Company Limited, "Publisher," "Co—Inc.," or "Co..Ltd."
4. If the document does not mention the publisher's name, list the name of the printing house with the term Printing House.
5. For publishers associated with universities or organizations, provide the full name, such as Thammasat University Press.
6. If the printer is a government or private organization, use the organization's name as the publisher.
7. If the name of the person responsible for printing is not stated, use 'n.p.' (no place of publishing) in English.

5.3.6 Year of Publication

1. Include the year of publication in numeric format, as it appears in the document.
2. If the publication year is not mentioned, use 'n.d.' (no date) in English.

5.3.7 Example of Bibliography Format

The specifications for referencing in the bibliography format are as follows:

1. Variables in different listings, such as author, day, month, year, and publisher, should use the regular Courier PC format.
2. Variables that need to be printed in bold should use the Courier Upright Bold format.
3. Terms that need to be printed in italics, such as 'ผู้แปล' (translator) or 'โดย' (by), should use the regular Arial Unicode MS format.
4. Replace single-letter spacing with the '/' symbol.
5. In cases where a single line is not sufficient, start the second line with the eighth character, leaving a space of 7 characters.
6. Other symbols such as '.', ',', ' ', ':", ' - ', '[]', should be printed as specified.

5.3.7.1 Book

Format:

Author./Publication Year./Title./Volume (if applicable)./Edition (if applicable)./City of Publication./Publisher.

Examples:

Single Author:

Sumner, M. 1990. Computer: Concept and uses. 2nd ed. New York: McGraw-Hill.

Two Authors:

Gilbert, A. and Gnglir, J. 1982.Cities Poverty and Development Urbanization in the Third World. London: Oxford University Press.

Multiple Authors:

Jackson, M.H. Stewart, D. and Steven, G. 1991.Environmental Health Reference Book. Oxford: Butterworth Heine-man.

Authors with Pseudonyms:

น.ม.ส. (นามแฝง). 2496. นิทานของ น.ม.ส. พิมพ์ครั้งที่ 3. พระนคร: คลังวิทยา.

5.3.7.2 Translated Books

Format

Author./Year BE. Publication Year./Book Title./Volume (if any)./Translated by Translator./Edition (if any)./City of Publication:/Publisher.

Or

Author./Year BE. Publication Year./Book Title./Volume (if any)./Translated from **Original Title**./by Translator./Edition (if any)./City of Publication:/Publisher.

Example

Davenport, J.H. 1993.**Computer Algebra**. Translated by Davenport, A and Davenport, J.H. 2nd ed. Great Britain : Academic Press.

Shafarevich, I.R. 1994. Basic Algebraic Geometry 1. translated from **Osnovy Algebraicheskoy Geometrii, tom 1**. by Reid, L. 2nd ed. New York : Springer.

5.3.7.3 Translated Books with Unspecified Original Author in the Original Language

Format

Translator Name,/Translator./Year BE. Publication Year./Book Title./Volume (if any)./Edition (if any)./City of Publication:/Publisher.

Example

Duang Bunnak, Translator. 2511. Economics. 2nd ed. Bangkok: Thammasat University.

Apichat Thaowto and Serm Sakkukul, Translators. 2526. Basic Knowledge of Rice Cultivation. Bangkok: Kasetsart University.

5.3.7.4 Books Authored by Organizations

Format

Organization Name./Year BE. Publication Year./Book Title./Volume (if any)./Edition (if any)./City of Publication:/Publisher.

Example

The Bank of Thailand. 1992. 50 Years of the Bank of Thailand 1942-1992. Bangkok : Amarin Printing Group.

5.3.7.5 Editors or Compilers

Format

Editor Name,/Editor (Compiler)/./Year BE. Publication Year./Book Title./Volume (if any)./Edition (if any)./City of Publication:/Publisher.

Example

Friedman, E.G., editor. 1995. Clock Distribution Networks in VLSI Circuits and Systems. New York : IEEE Press.

5.3.7.6 Conference Proceeding or Articles from Books

Format

Author of the Article./Year BE. Publication Year./ "Article Title (Conference Report)."/Page/Page Range./In/Editor (Compiler)./Book Title./Volume (if any)./Edition (if any)./City of Publication./Publisher.

Example

Niwa, E. 1992. "Chemistry of surimi gellation." 115-118. in Lainier, T.C. and Lee, C.M. Surimi Technology. New York : Marcel Dekker

Goemans, M.X. and Williamson, D.P. 1995. "The Primal-dual Method for Approximation Algorithms and its Application to Network design Problems." 69-87. in Hochbaum, D. Approximation Algorithms for NP-hard Problems. Boston : PWS.

5.3.7.7 Journal Articles

Format

Author./Publication Year./ "Article Title."//Journal Name./Volume(Issue)/:Page Range.

Bentley, M Lee. 1986. "The Role of Backcountry Experience in Middle School Environmental Education," Dissertation Abstracts Internation. 46(10) : 2900-A-2901-A.

Choomchuay, S. 1994. "On the Implementation of Finite Field Operation." Ladkrabang Engineering Journal. 11(1) : 7-16.

Hitchcock, R.B. et. al. 1982. "Timing Analysis of Computer Hardware." IBM J. Res. Develop. 26(1) : 100-105.

Klein, P. et. al. 1995. "An approximate max-flow min-cut relation for undirected multi-Commodity flow, with applications." Combinatorica. 15(2) : 187-202.

5.3.7.8 Thesis and Dissertation

Format

Author./Year BE. Publication Year./ "Thesis Title."//Degree Name (Full).

Example

Choomchuay, S. 1993. "Algorithm and Architecture for Reed-Solomon Decoding." Ph.D.Thesis of University of London and the Diploma of Membership of the Imperial College.

Burns, B. 1991. "Performance Analysis and Optimization of Asynchronous Circuits." Ph.D. Dissertation, California Institute of Technology.

5.3.7.9 Reviews

Format

Reviewer Name./Review of/Title of the Reviewed Work./by/Author Name./In/Book Title (where the review appears)./Edition (if any)./Page Range.

Example

Chamnan Nakprasom. Review of the book Lai Suea Siam by S. Siwarak. Social Perspectives Journal, Volume 5(1), Issue 1 (June-August 2510): 139-141.

5.3.7.10 Articles in Encyclopedias or Dictionaries

Format

Author.//”Article Title.”//Encyclopedia or Dictionary Name.//Volume (Publication Year).://Page

Range.

Example

Prapat Trinanong. 2513. ”Chor Fa.” Thai Encyclopedia by the Royal Institute, Volume 10: 6076-6080.

5.3.7.11 Newspaper Articles

Format

Author.//Publication Year, Date, Month.//”Article Title.”//Author of the Article.//Newspaper Name.//Page/Page

Range.

Example

Goleman, D. 1985, 21 May. ”New Focus on Multiple Personality.” New York Times. Pages c1-c6.

5.3.7.12 News Monitoring and Facts Checking in Newspapers Over a Period

Format

Newspaper Name.//Date, Month//Year of Publication - Date, Month//Year of Publication.

Example

Thai Rath. January 4, 2538 - February 5, 2538.

5.3.7.13 Newsletters, Photocopies, and Unpublished Documents

Format

Author.//Year BE. Publication Year.//”Document Title.”//Edition (if any).//City of Publication://Publisher.//Document Copy.

Example

Sakallah, K.A. et. al. 1989. ”Analysis and Design of Latch-Controlled Synchronous Digital Circuits.” Ann Arbor, Mi, : Dept. of EECS University of Michigan Technical Report CSE-TR-31-89.

5.3.7.14 Government Publications and Other Official Documents

Format

Organization Name.//Publication Year.//Publication Title.//Edition (if any).//City of Publication://Publisher.

Example

Office of the Secretary-General of the House of Representatives. 2522. Reports of the 8th-9th Representative Assembly Regular Session Volume 3. Bangkok: Printing Office of the Cabinet.

5.3.7.15 Interviews

Format

Interviewee Name./Interviewer./Date, Month Year of the Interview./Interviewer Name./Interview Title./Interview Location.

Example

Manas Sangwarasilp Interviewed, April 18, 2541. Somsak Chumchuay, Interviewer. Interview on the Improvement Guidelines for Graduate Programs of the Institution. Graduate School, King Mongkut's Institute of Technology Ladkrabang.

5.3.7.16 Audiovisual Materials

1) Slides, Filmstrips, Videos, Tape Recordings, Compact Discs

Format

Creator./Year BE. Production Year./Title./[Type of Medium]/Place of Production:/Producer.

Example

Charoen Prokpun Ltd. 2525. Chicken Farming. [Video]. Bangkok: Charoen Prokpun Ltd.
 Alan W.B. Compiler. 1984. Using the Oscilloscope. [Slide]. London : The Slide Centre.
 RCA Records. 1984. Test Compact Disc ; Extensive Test for Audio Equipment. [Compact Disc].
 Germany : RCA Ltd.

2) Maps

Format

Name [Map Type]/Publication Year./Publication Title./Publisher.

Example

Scotland [Photographic map]. Washington (DC) : National Geographic Society (US.)

5.3.7.17 Patents

Format

Patentee./Invention Name./Country of Patent./Patent Number./Date of Patent Grant.

Example

Kamder, A.D. Method and Apparatus for Constraining the Compaction of Components of a Circuit Layout. U.S patent no. 5636132, June 1997.

5.3.7.18 Electronic Media

Format

Author./Publication Year./Title./[CD-ROM]/Place of Production:/Producer.

or

Author./Publication Year (or Retrieval Date)/Title./[Online]/Available:/Access Method and Data Location.

Examples

Daniel H., Anghileri. 1995. Secondary Mathematics and Special Education Needs. [CD-ROM]. New York: Casell.

Noam E.M. 1994 Telecommunication Policy Issue for the Next Century. [Online]. Available: Gopher://198.80.36.../global/telecom.txt.

Texas Instruments. 1998. Speech synthesis Processors. [Online]. Available: <http://www.ti.com/sc/docs/msp/speech/dex.htm>.

5.3.8 Example Formats for References Citation

5.3.8.1 Book

Format

Author./Book Title./Edition (if any)./City of Publication./Publisher./Publication Year BE.

or

Editor Name./Editor (Compiler)./Book Title./Edition (if any)./City of Publication./Publisher./Publication Year BE.

Example

[1] Richard E. Blahut. Theory and Practice of Error Control Codes. Reading : Addison-Wesley publishing Company, Inc.1984.

[2] Judith S.Van ALSTYNE. Professional and Technical Writing Strategies. International Edition. New JERSEY : Prentice-Hall, Inc. 1986.

[3] Jose E. Franca, Yannis Tsividis, Editors. Design of Analog-Digital VLSI Circuits for Telecommunication and Signal Processing. 2nd ED. New Jersey : Prentice-Hall, Inc.1994

[4] Microsoft. Hardware Design Guide for Window 95 ; A Practical Guide for Developing Plug and Play PCs and Peripherals. Washington D.C. : Microsoft Press. 1994.

[5] Microelectronics Group, Lucent Technology. Field-Programmable Gate Arrays [data Book]. LUCENT Technology. October 1996. Pp.2-36-2-40.

5.3.8.2 Articles from Journals, Books, or Conference Proceedings

Format

Author./"Article Title."//Journal Name./Volume,/Issue Number./Month Year of Printing./Page/Page Range.

Example

[1] Choomchuay S. "On the Implementation of Finite Field Operations" Ladkrabang Engineering Journal, vol.11,no, 1, June 1984. pp.7-17.

[2] Shao M., Reed S. "On the VLSI Design of a Pipeline Reed-Solomon Decoder Using Systolic Arrays." IEEE Trans. On Comput., vol. C-37, no. 10, Oct. 1988. pp. 1273-1280

[3] Sukiyaama Y., Kasahara M., Hirasawa S. and Namekawa T. "A Method for Solving key Equation for Decoding Coppa Codes.", Inf. And Cont., vol.27, 1975. Pp. 87-99

[4] Choomchuay S., Arambepola B. "An Algorithm and a VLSI Architecture for Reed – Solomon Decoding" Proc. IEEE-ISCAS, San Diego, USA, May, 1992. Pp.2120-2123

5.3.8.3 Thesis and Dissertation

Format

Author.// "Thesis Title."// "Full Degree Name."//Year of Publication BE.

Example

[1] Choomchuay S. "Algorithm and Architecture for Reed-Solomon Decoding." Ph.D. Thesis of University of London and the Diploma of Membership of the Imperial College. 1993

5.3.8.4 Patents

Format

Patent Holder.//Invention Title.//Country of Patent.//Patent Number.//Date of Patent Registration (Day, Month, Year).

Example

[1] Kandar A.D. "Method and Apparatus for Constraining the Compaction of Components of a Circuit Layout." U.S patent no. 5636132, June 1997

5.3.8.5 Visual Materials and Other Media

Format

Producer.// "Title." // [Type of Media]//Place of Production.//Producer.//Year of Production BE.

Example

[1] RCA Records. "Test Compact Disc ; Extensive Test Audio Equipment." [Compact Disc]. Germany : RCA Ltd. 1984.

[2] Alan W.B. Compiler. "Using the Oscilloscope." [Slide]. London : The Slide Center. 1984.

5.3.8.6 Electronic Media

Format

Author.// "Title." // [CD-ROM]// Place of Production.//Producer.//Year of Release BE.

Or

Author.// "Title." // [Online]//Available at://Access Method and Source.//Year of Publication BE (or retrieval).

Example

[1] Daniel H., Anghileri. "Secondary Mathematics and Special Education Needs." [CD-ROM]. New York : Casell.1995

[2] Noam E.M. "Telecommunication Policy Issue for the Next Century." [Online]. Available : gopher://198.80.36.../global/telcom.txt. 1994.

[3] Texas Instruments. "Speech Synthesis Processors." [Online]. Available : <http://www.ti.com/sc/does/msp/speech/dex.htm>. 1998.

[1]

Bibliography

- [1] Xuechen Zhang, Zhengmin Wu, Chengmao Cao, Kun Luo, Kuan Qin, Yangyang Huang, and Jie Cao. Design and operation of a deep-learning-based fresh tea-leaf sorting robot. *Computers and Electronics in Agriculture*, 206:107664, 2023.

Appendix A
GUIDELINES AND PROCEDURES FOR THESIS WRITING

Thesis writing is considered a crucial part for graduate students after completing coursework at a certain level. Students must plan their thesis writing process until the comprehensive thesis examination is completed.

Procedures for Requesting Approval of Thesis Topics and Scheduling Thesis Examinations:

1. Graduate students have the right to propose thesis topics as soon as they become enrolled in the graduate program.

2. Students must submit a request for approval of the thesis topic to the graduate school of their respective faculty.

3. The approval of the thesis topic and the thesis outline is within the authority of the dean, endorsed by the academic affairs committee.

4. Students must receive approval of the thesis topic and the outline (if any) before the final thesis examination.

5. Any changes before the thesis examination must be handled as follows:

5.1 **Change of thesis topic or outline:** Students must submit a request to the dean, with approval from the thesis advisor and endorsement from the academic affairs committee.

5.2 **Change of thesis advisor:** Students must submit a request to the dean of the respective academic unit, and the dean has the authority to approve, with endorsement from the academic affairs committee.

5.3 In cases where the thesis advisor loses their position within the academic unit, the student must find a new advisor, and the work specified by the owner of the work, including the student's name, the name of the thesis advisor, the name of the academic unit, and the name of the institution, should be used to support the thesis examination application.

6. The thesis examination is the final stage, and students must comply with the conditions and requirements of each program in their respective academic units. Students can only take the thesis examination when:

6.1 The thesis advisor believes that the student is ready for the examination. The student must notify the examination committee and submit a draft of the thesis to the specified number of graduate students, faculty, and the examination committee no less than two weeks in advance.

6.2 For master's degree examinations, the branch chairman and the course coordinator must conduct the thesis examination committee, endorsed by the academic affairs committee. The committee should consist of five members, including the thesis advisor, one graduate faculty member proposed by the thesis advisor, and three members, including an outside faculty member who is an expert, proposed by the academic affairs committee. The committee must appoint the external committee member as the committee chairman.

6.3 For doctoral degree examinations, the dean should appoint the thesis examination committee, endorsed by the academic affairs committee. The committee should consist of five members, including the thesis advisor, one faculty member proposed by the thesis advisor, and three members, including an outside faculty member who is an expert, proposed by the academic affairs committee. The committee must appoint the external

committee member as the committee chairman.

AUTHOR BIOGRAPHY



Name Mr. First Name Last Name
Date of Birth January 1, 1990, in Bangkok

John Doe was born in Bangkok, Thailand, on January 1, 1995. He received his Bachelor of Engineering degree in Robotics and AI Engineering from KMITL in 2017. He is currently pursuing a Master of Engineering degree in Robotics and AI Engineering at KMITL. His research interests include machine learning, computer vision, and robotics.