



**UTM**  
UNIVERSITI TEKNOLOGI MALAYSIA

UNIVERSITI TEKNOLOGI MALAYSIA

# THESIS WRITING GUIDELINES 2023

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Prepared By:  
School of Graduate Studies

**School of Graduate Studies  
Universiti Teknologi Malaysia  
Thesis Writing Guidelines**

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Prepared by:  
School of Graduate Studies  
Universiti Teknologi Malaysia  
81310 Johor Bahru,  
Johor  
<http://www.sps.utm.my>

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## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b>	<b>3</b>
<b>LIST OF APPENDICES</b>	<b>6</b>
<b>EDITORIAL MEMBERS</b>	<b>7</b>
<b>PREFACE</b>	<b>8</b>
<b>CHAPTER 1      GENERAL REQUIREMENTS</b>	<b>9</b>
1.1      Introduction	9
1.2      Thesis, dissertation and Master's project report	9
1.3      UTM thesis format	9
1.3.1      Conventional Thesis/Dissertation	10
1.3.2      Thesis by Publications	12
1.4      Copyright of thesis	15
1.5      UTM Thesis Template	16
<b>CHAPTER 2      LAYOUT AND CONTENT</b>	<b>17</b>
2.1      Introduction	17
2.2      Language	17
2.3      Printing	17
2.4      Thesis Title	18
2.5      Number of Pages	18
2.6      Page Layout	19
2.7      Type of Paper	19
2.8      Typeface and Font Size	19
2.9      Margins	19
2.10      Spacing	20
2.11      Pagination	21
2.12      Binding	21

<b>CHAPTER 3</b>	<b>THESIS FORMAT AND ARRANGEMENT</b>	<b>24</b>
3.1	Introduction	24
3.2	Classification of Theses	24
3.3	Declaration by Supervisor(s)	26
3.4	Declaration of Cooperation with External Agencies/Entities	26
3.5	Certification of Examination	26
3.6	Title Page	26
3.7	Statement of Award	27
3.8	Author's Declaration of Originality	28
3.9	Acknowledgements	28
3.10	Abstract	28
3.11	List of Tables	29
3.12	List of Figures	30
3.13	List of Symbols/Abbreviations/Acronyms/Notations	30
3.14	List of Appendices	30
3.15	Chapter Layout	30
3.16	Tables	31
3.17	Figures	33
3.18	Equations	34
3.19	Footnotes	36
3.20	References	36
3.21	Appendix	37
3.22	List of Publications	37
<b>CHAPTER 4</b>	<b>REFERENCES, COPYRIGHT AND PLAGIARISM</b>	<b>38</b>
4.1	Introduction	38
4.2	Formatting	38
4.3	Referencing Style	38
4.4	Referencing Software	39
4.5	Citing in Text	39

4.6	Third-Party Copyright Materials	40
4.7	Seeking permission to use third-party copyright materials	40
4.8	Plagiarism	41
4.9	Editing and Proofreading	41
4.10	The use of generative artificial intelligence (AI)	43
<b>CHAPTER 5</b>	<b>ELECTRONIC THESES AND DISSERTATIONS</b>	<b>44</b>
5.1	Introduction	44
5.2	Electronic Theses and Dissertation (ETD)	44
5.2.1	Pre-Access File	45
5.2.2	Full-Text File	45
5.2.3	Labelling the Pre-Access and Full-Text Files	45

## LIST OF APPENDICES

Appendix A	Thesis Front Cover	50
Appendix B	Declaration of Thesis/Dissertation/Project Form	51
Appendix C	Restricted and Classified Thesis Status Declaration Letter	52
Appendix D	Declaration by Supervisor	53
Appendix E	Declaration of Cooperation	54
Appendix F	Certification of Examination	55
Appendix G	Title Page	56
Appendix H	Author's Declaration of Originality	57
Appendix I	Acknowledgement	58
Appendix J	English Abstract	59
Appendix K	Malay Abstract	60
Appendix L	Table of Contents	61
Appendix M	List of Tables	63
Appendix N	List of Figures	64
Appendix O	List of Abbreviations/Acronyms	65
Appendix P	List of Symbols	66
Appendix Q	List of Appendices	67
Appendix R	Chapter Layout	68
Appendix S	List of Publications	70

## EDITORIAL MEMBERS

The editorial members of the 2023 edition of UTM Thesis Guidelines are:

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## **PREFACE**

The highlight of a postgraduate student's journey is the completion of their research work in the form of a thesis. As a document, the thesis showcases the student's achievement, knowledge, and skills in their field of specialisation.

The UTM thesis is a document bound by certain conventions and rules. This guideline helps students in the preparation of their theses, providing formatting and writing conventions that comply with the university's requirements. It contains both general and specific instructions used in preparing the thesis for final submission, including instructions on matters relating to formatting, length, footnotes, tables and appendices, bibliography/references, and citation and referencing styles.

This is the sixth edition of the guideline. It retains the general format of the thesis and offers the choice of two thesis formats. In addition to providing an update, doing general editing, and refining the contents, we have made two significant additions, namely the areas of plagiarism and copyrights.

As technology continues to evolve and access to materials through the internet becomes easier, the issues of plagiarism and infringement of copyright have become concerns. A section on plagiarism has been added, which indicates that there is a strict prohibition on plagiarism. Plagiarism puts the student at risk of termination of their candidature.

Students should closely refer to this guide and seek clarification from the School of Graduate Studies (SPS) on specific matters relating to the preparation of their theses.

Thank you and all the best!

*School of Graduate Studies & Editorial Team 2023*

## CHAPTER 1

### GENERAL REQUIREMENTS

#### 1.1 Introduction

This chapter describes the three types of research documentation submitted for postgraduate degrees at UTM: theses, dissertations, and Master's project reports. It also defines the two UTM thesis formats: conventional format and thesis by publications. Students are permitted to select the format most suitable for their academic discipline.

#### 1.2 Thesis, dissertation and Master's project report

A thesis, dissertation or Master's project report is a document that presents students' research and findings in support of their candidature for an academic degree. In UTM, a *project report* refers to the documentation of the research component prepared and submitted by the candidate for the award of a master's programme by coursework. On the other hand, a *dissertation* refers to a document submitted by a student in partial fulfilment for the award of a degree through a mixed-mode program. Finally, a *thesis* refers to the documentation of original research prepared and submitted by a candidate for the award of a degree for a doctoral or master's programme based on research.

#### 1.3 UTM thesis format

A thesis can be written in one of the following formats:

- a) **Conventional thesis:** A conventional thesis typically consists of five chapters: the introduction, the literature review, the methodology, the results, and the conclusion.
- b) **Thesis by publications:** A thesis by publications consists of a compilation of scholarly papers published by the student as the first author during their candidature. Students who intend to submit their theses in this format must adhere to the publication requirements outlined in the graduate school regulations.

Following are guidelines for composing and preparing a dissertation or thesis in accordance with the two formats.

### 1.3.1 Conventional Thesis/Dissertation

In general, a conventional thesis/dissertation consists of three main parts: preliminary, main body and supplementary. Details on typesetting are provided in Chapter 2 of this manual. The general structure of a conventional thesis/dissertation is shown in Table 1.1 below.

Table 1.1 General Structure of a Conventional Thesis/Dissertation

COMPONENT	STATUS	SAMPLE PAGE	NOTE
<b>PRELIMINARY</b>			
Front Cover		Appendix A	Without a page number
Blank Page			Without a page number
Declaration of Thesis/Dissertation/ Project Form		Appendix B	Without a page number
		Appendix C	Required if the thesis is classified as 'Restricted'
Declaration by Supervisor(s)		Appendix D	Without a page number

Declaration of Cooperation	Compulsory	Appendix E	Without a page number
Certification of Examination		Appendix F	Without a page number
Title Page		Appendix G	Counted as (i) but the page number is not printed.
Author's Declaration of Originality		Appendix H	Roman numeral (iii)
Acknowledgement		Appendix I	Roman numeral (v)
Abstract (English)		Appendix J	Roman numeral (vi)
Abstrak (Malay)		Appendix K	Roman numeral (vii)
Table of Contents		Appendix L	Continues from the previous Roman numeral
List of Tables		Appendix M	Continues from the previous Roman numeral
List of Figures		Appendix N	Continues from the previous Roman numeral
List of Abbreviations		Appendix O	Continues from the previous Roman numeral
List of Symbols		Appendix P	Continues from the previous Roman numeral
List of Appendices		Appendix Q	Continues from the previous Roman numeral
<b>MAIN BODY</b>			
Chapter 1: Introduction	Compulsory	Appendix R	Arabic numeral; starts at (1)
Chapter 2: Literature Review			Continues from the previous Arabic numeral
Chapter 3: Methodology			Continues from the previous Arabic numeral
Chapter 4: Results			Continues from the previous Arabic numeral
Chapter 5: Discussion			Continues from the previous Arabic numeral
Chapter 6: Conclusion			Continues from the previous Arabic numeral
References			Continues from the previous Arabic numeral
<b>SUPPLEMENTARY</b>			

Appendices	Compulsory		Continues from the previous Arabic numeral
List of Publications and Papers Presented		Appendix S	Continues from the previous Arabic numeral

**Note: Additional chapters are allowed depending on the needs of the study**

### 1.3.2 Thesis by Publications

UTM recognises the submission of a thesis in the form of a collection of published papers produced by students during their candidature. This format is appropriate only for research-based degree programmes. Papers used in the thesis must be based on a particular theme/focus and form a cohesive and coherent write-up. Each article should address a specific research objective or a topic directly related to the study. In Chapter 2 of this manual, specifics on typesetting are provided. The typical format of a thesis by publications is displayed in Table 1.2.

Table 1.2 General Structure for a Thesis by Publications

COMPONENT	STATUS	SAMPLE PAGE	NOTE
<b>PRELIMINARY</b>			
Front Cover	Compulsory	Appendix A	Without a page number
Blank Page			Without a page number
Declaration of Thesis/Dissertation/ Project Form		Appendix B	Without a page number
		Appendix C	Required if the thesis is classified as 'Restricted'
Declaration by Supervisor(s)		Appendix D	Without a page number
Declaration of Cooperation		Appendix E	Without a page number
Certification of Examination		Appendix F	Without a page number
Title Page		Appendix G	Counted as (i) but the page number is not printed.

Author's Declaration of Originality		Appendix H	Roman numeral (iii)
Acknowledgement		Appendix I	Roman numeral (v)
Abstract (English)		Appendix J	Roman numeral (vi)
Abstrak (Malay)		Appendix K	Roman numeral (vii)
Table of Contents		Appendix L	Continues from the previous Roman numeral
List of Tables		Appendix M	Continues from the previous Roman numeral
List of Figures		Appendix N	Continues from the previous Roman numeral
List of Abbreviations		Appendix O	Continues from the previous Roman numeral
List of Symbols		Appendix P	Continues from the previous Roman numeral
List of Appendices		Appendix Q	Continues from the previous Roman numeral
<b>MAIN BODY</b>			
Chapter 1: Introduction	Compulsory	Appendix R	Arabic numeral; starts at (1)
Chapter 2: Literature Review (especially if it is not covered in-depth within the paper)			Continues from the previous Arabic numeral
Chapter 3: Article 1			Continues from the previous Arabic numeral
Chapter 4: Article 2			Continues from the previous Arabic numeral
Chapter 5: Article 3			Continues from the previous Arabic numeral
Chapter 6: Discussion			Continues from the previous Arabic numeral
References			Continues from the previous Arabic numeral
<b>SUPPLEMENTARY</b>			
Appendices (One of the appendices <b>must include a statement of the contribution</b> of each author)	Compulsory		Continues from the previous Arabic numeral
List of Publications and Papers		Appendix S	Continues from the previous Arabic numeral

**Note: Additional chapters are allowed depending on the needs of a study**

A thesis by publication begins with Chapter 1 which introduces the thesis. A full explanatory overview is required to link published papers to the research thesis. This chapter may include sections such as an overview of the thesis, background of the problem, problem statement, objectives, research scope and organization of the thesis. In Chapter 2, students are required to review related literature, particularly areas that are not covered in-depth within the papers. Chapter 3 describes the findings from Article 1. The findings must relate to the problem statement and research objectives highlighted in Chapter 1. The same format applies to chapters 4 and 5. Finally, Chapter 6 summarizes the findings from the 3 publications, providing an overview of the important contributions of your work, while suggesting academic and practical implications resulting from your findings and specifying future research suggestions.

Candidates must obtain permission from the Faculty, School of Graduate Studies and other co-authors for all papers used as part of their PhD thesis. To fulfil this requirement, candidates must complete the *request to submit thesis by publication form* and the *co-author authorisation form*. Please refer to the School of Graduate Studies website and the Academic Rules of Graduate Studies for the latest requirements and conditions for thesis by publications submission.

A clear *statement of the contribution* made by each author in any jointly-published work is required and must be included as one of the appendices. For example, a statement of contribution from a three-author academic research publication is as follows:

**Publication:** Andalib Touchaei, S., & Noor Hazarina, Hashim. (2023). The Antecedents of Mobile Banking Adoption among Senior Citizens in Malaysia. *International Journal of Human-Computer Interaction*, 1-18.

**Statement of Contributions:** Andalib Touchaei, S. conducted all experiments, coordinated the data analysis, and contributed to the writing of the manuscript. Noor

Hazarina, Hashim supervised the development of the work and edited the manuscript and gave technical support and conceptual advice and helped in data interpretation.

#### **1.4 Copyright of thesis**

Universiti Teknologi Malaysia owns the thesis's copyright. As the copyright holder, the university has the following rights to the student's thesis:

- (a) Reproducing the thesis
- (b) Publishing the thesis or making it available to the public
- (c) Communicating the thesis, for example by making it available online.

Students, as the authors, have moral rights over their theses. Creators of copyrighted material hold moral rights in the material they create even if they do not hold copyright. Moral rights include the right:

- (a) To be acknowledged or attributed as the creator of the work
- (b) Not to have their work falsely attributed, meaning another person is acknowledged as the creator
- (c) Not to have their work used in a derogatory or prejudicial manner.



## **1.5 UTM Thesis Template**

UTM provides both a Microsoft Word Template (.dotx) and LaTeX thesis template. It is mandatory to use the provided template for ease of thesis formatting. However, the number and title of chapters are not restricted by the template. The template can be downloaded from the School of Graduate Studies website.

## **CHAPTER 2**

### **LAYOUT AND CONTENT**

#### **2.1 Introduction**

This chapter provides an explanation of the writing conventions, layout, and formatting that are to be utilised in the process of preparing a thesis.

#### **2.2 Language**

The thesis may be composed in either English or Bahasa Melayu. However, candidates from the Academy of Islamic Civilization, Faculty of Social Sciences and Humanities, have the option to write in Arabic. Language usage and orthography conventions (American or British) should be consistent throughout the thesis. The Roman alphabet should be used unless specified otherwise by the discipline.

#### **2.3 Printing**

Theses for oral examination and hardbound submission must be laser-printed on both sides of the paper.

## 2.4 Thesis Title

A thesis title must adhere to the following guidelines:

- (a) It should be a clear and concise description of the focus and contribution of the research.
- (b) It should not contain redundant phrases reflecting a research exercise, such as ‘An investigation of...’, ‘A preliminary study of...’, ‘A study of...’, ‘Analysis of...’, ‘On the....’, ‘Theory of ....’, ‘Some...’, and ‘Toward a....’.
- (c) The thesis title may contain common acronyms used in the field of study.

## 2.5 Number of Pages

The maximum number of pages for a thesis/dissertation/project report is as follows:

- (a) Master’s Project Report/Dissertation/Thesis: 200 pages
- (b) Doctoral Thesis: 300 pages

This page counts include tables, figures, and other illustrations but **exclude** appendices and the list of references. The maximum number of pages allowed for appendices is 50.

## **2.6 Page Layout**

The text should be presented in a portrait layout. Landscape layout may be used for figures and tables.

## **2.7 Type of Paper**

For viva-voce copies, high-quality A4 size (210 x 297 mm) paper with a weight of 80 grams per square metre (gsm) in white simili should be used. For hardbound copies, it is necessary to use B5-size paper. Photocopies of the thesis must be on similar quality paper.

## **2.8 Typeface and Font Size**

A thesis should be typed using a word or text processor. The 12-point font size commonly used in printed academic materials should be used. Examples of suggested font types are Serif (Times New Roman or Book Antiqua *only*) and Sans Serif (Arial, Tahoma or Calibri *only*). The same font type should be used throughout the thesis.

## **2.9 Margins**

All pages should have the same margin. The left and right margins should be 3.25 cm (for binding purposes), and the top and bottom margins should be 2.5 cm.

## 2.10 Spacing

The following guidelines should be observed:

- (a) The spacing between the chapter title and the first line of a text should be four (4) line spaces.
- (b) The spacing between the last line of a text and the title of a sub-section should be four (4) line spaces.
- (c) The spacing between the title of a sub-section and the first line of a text should be two (2) line spaces.
- (d) The spacing between paragraphs should be two (2) line spaces.
- (e) The number and the title of a sub-section should be aligned with the left margin.
- (f) The first line of a paragraph should be indented by 1.27 cm (0.5 in) from the left margin.
- (g) A new paragraph should not begin on the last line of a page.
- (h) The spacing between the last line of a text and a table or a figure or an illustration should be two (2) line spaces.
- (i) The spacing after a comma (,) should be one (1) character space.

## **2.11 Pagination**

Pages should be numbered consecutively including the blank page when transitioning to a new chapter. The page numbers should be positioned at the bottom centre, 1.25 cm from the bottom edge. Numbering should adhere to the following guidelines:

- (a) Preliminary pages of a thesis, starting from the title page, should be numbered using lowercase Roman numerals (i, ii, iii, etc.). Pages in the main text should be numbered using Arabic numerals (1, 2, 3, etc.).
- (b) The first page should be the title page. This page should be counted as 'i' but should not be printed.
- (c) Each chapter's first page should commence on an odd page with the page number printed.
- (d) Theses that require partition pages should not have their partition pages numbered or counted.
- (e) If a chapter terminates on an odd page number, a blank page should be added and counted, but the page number should not be printed. (In MS Word, insert 'Section Breaks Odd Page' under the Layout Tab).

## **2.12 Binding**

Students must ensure that all university requirements have been met and necessary signatures have been obtained before binding their theses. The details of the thesis cover are shown below.

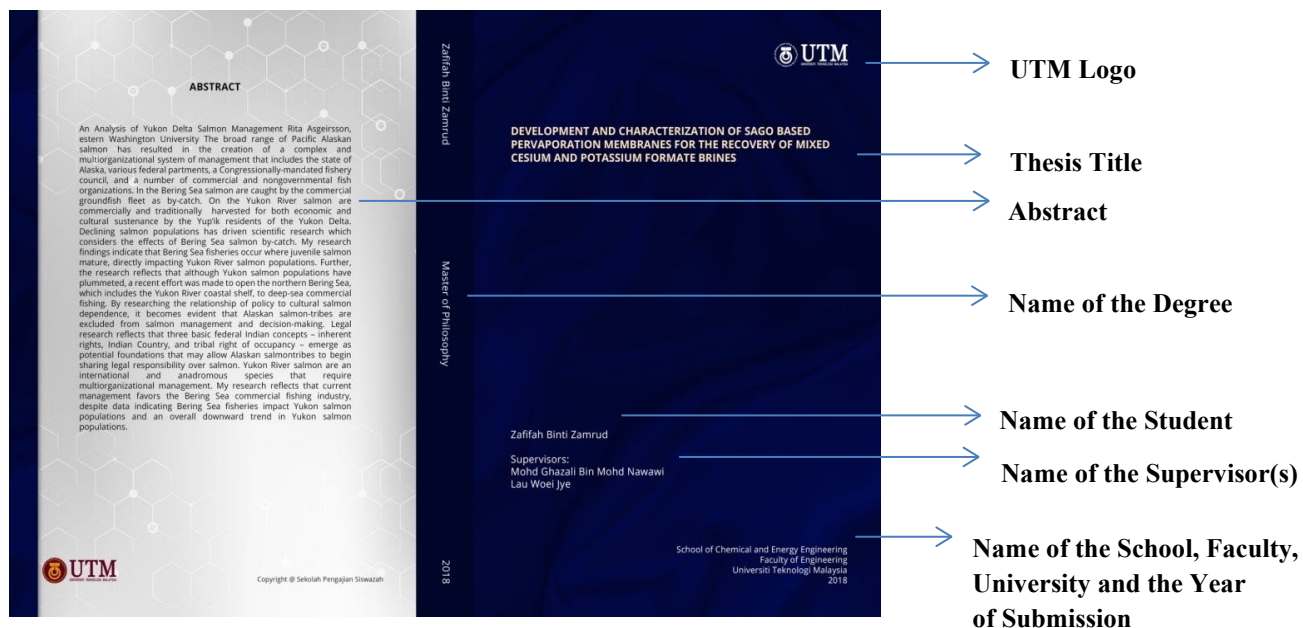


Figure 2.1 Details of a Thesis Cover for a Master's Degree

Size	B5
Colour	<i>Royal Blue</i>
Colour code	#01073d
RGB code	R1G7B61
Paper weight (front and back cover)	1400 gsm
Type of paper	80 gsm
Printing	Double-sided
Cover of the thesis	Hardcover perfect: Holland art paper +

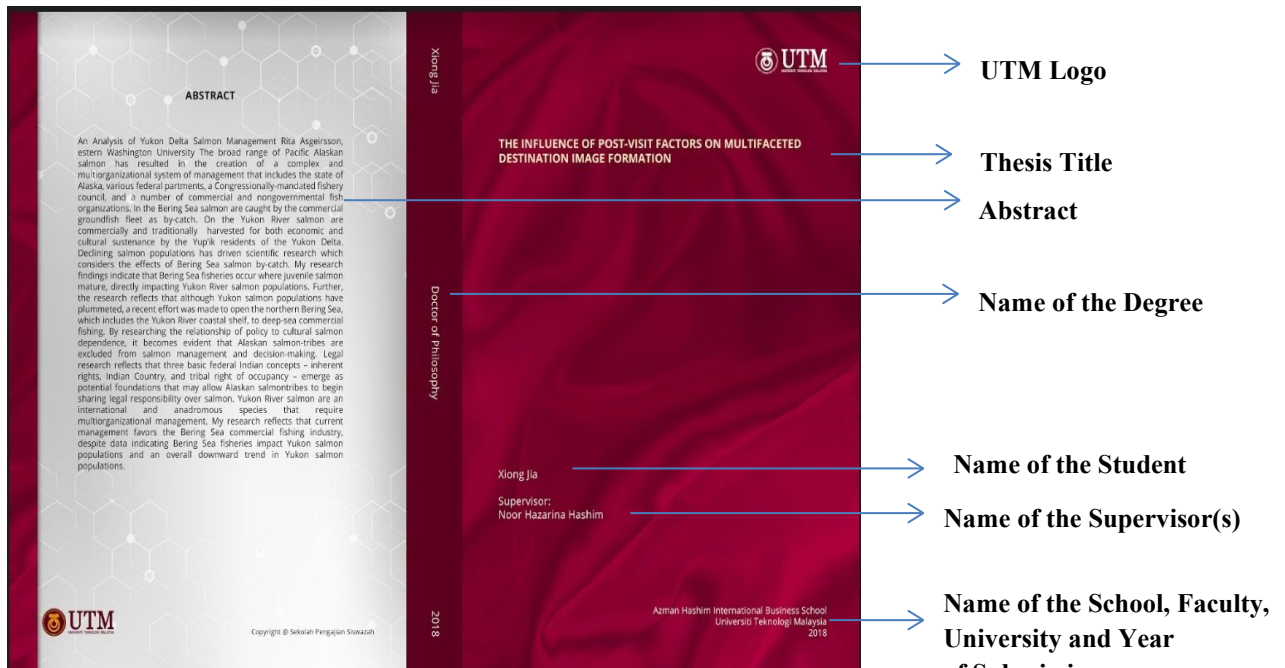


Figure 2.2 Thesis Cover Details for a Doctor of Philosophy Degree

Size	B5
Colour	<i>Dark red</i>
Colour code	#5C001F
RGB code	R92G0B3
Paper weight (front and back cover)	1400 gsm
Type of paper	80 gsm
Printing	Double-sided
Cover of the thesis	Hardcover perfect: Holland art paper + laminate



## CHAPTER 3

### THESIS FORMAT AND ARRANGEMENT

#### 3.1 Introduction

The following section describes the format and layout of a UTM thesis. It outlines the required content for a thesis as well as the writing conventions for tables, figures, and equations.

#### 3.2 Classification of Theses

A UTM thesis must be classified as 'Open Access,' 'Confidential,' or 'Restricted' on the Thesis Status Declaration form issued by the UTM Library (Appendix B). The following is the definition for the three classifications:

- a) **Open Access:** The thesis will be available to the public.
  
- b) **Confidential:** The thesis contains confidential information pursuant to the Official Secrets Act of 1972.
  
- c) **Restricted:** The thesis contains restricted data as specified by the organisation where the research was conducted.

Students, in consultation with their advisors, are responsible for building a structured case to support their application for a restricted or confidential thesis. Any thesis designated 'Confidential' or 'Restricted' must be accompanied by a letter from the individual who made the designation (see **Appendix C**). The letter should clearly indicate the reason for the classification and the duration of the classification. In exceptional circumstances, the Senate may, upon request, restrict access to a thesis for two years following the date of degree conferral. The following are some of the reasons why a thesis may be classified as restricted or confidential.

- a) requirements to keep information secret.
- b) requirements to restrict how information is expressed.
- c) requirements to keep the source of information private.
- d) Ethical standards for conducting research and disclosing confidential information.
- e) contractual agreements to maintain confidentiality of information.
- f) information that cannot be legally reproduced.

Three (3) years is the typical duration for classifying a thesis as confidential or restricted. The duration may, however, be extended up to a maximum of five (5) years. If the thesis's status declaration form is not submitted or is incomplete, the university will assume that the thesis is unrestricted and will make the thesis available for distribution as a published academic exchange material.

When a thesis is designated as 'confidential' or 'restricted,' none of its components can be revealed. Students should be aware that imposing a restriction will prevent them from demonstrating in the repository that their theses have been published. A restriction on a thesis has no bearing on the awarding of a degree.

### **3.3 Declaration by Supervisor(s)**

A thesis submitted for examination must include a declaration from the supervisor(s) attesting that it fulfils the required scope and quality (Refer to **Appendix D**).

### **3.4 Declaration of Cooperation with External Agencies/Entities**

If there was any cooperation or collaboration with external agencies or entities during the research which led to the submission of the thesis, the Declaration of Cooperation Form must be included (Refer **Appendix E**).

### **3.5 Certification of Examination**

This section provides the name of thesis examiners and certification of examination from the faculty/school (Refer **Appendix F**).

### **3.6 Title Page**

Please refer to **Appendix G** for the layout of the title page. The title page contains the following elements:

- (a) Title of the thesis
- (b) Student's full name as stated in the identity card or passport (for international students)
- (c) Statement of the award for the thesis (please refer to Section 3.7)

- (d) Name of the school where the student is enrolled (if applicable)
- (e) Name of the faculty where the student is enrolled
- (f) Name of the university
- (g) Month and year of thesis submission

### 3.7 Statement of Award

This statement should be written on the title page and should state the purpose and the award for the thesis. Examples of statements for various purposes and awards are listed below:

<b>MASTER'S DEGREE</b>	
<b>Masters by Coursework (Open and Distance Learning [ODL] &amp; Conventional)</b>	<b>Masters Dissertation by Mixed Mode (ODL &amp; Conventional)</b>
A project report submitted in partial fulfilment of the requirements for the award of the degree of <i>(name of the program)</i>	A dissertation submitted in partial fulfilment of the requirements for the award of the degree of <i>(name of the program)</i>
<b>Masters Thesis By Research</b>	
A thesis submitted in fulfilment of the requirements for the award of the degree of <i>(name of the program)</i>	
<b>DOCTORAL DEGREE</b>	
<b>Doctoral Degree by Coursework (i.e., Engineering Doctorate, Doctor of Business Administration)</b>	<b>Doctor of Philosophy</b>
A dissertation submitted in partial fulfilment of the requirements for the award of the degree of <i>Doctor of Engineering / Doctor of Business Administration</i>	A thesis submitted in fulfilment of the requirements for the award of the degree of <i>(name of the program)</i>

### **3.8 Author's Declaration of Originality**

This page contains a declaration by the student on the originality of his/her thesis. The declaration must be signed by the student. Please refer to **Appendix H**.

### **3.9 Acknowledgements**

In the acknowledgements section, the author expresses gratitude to those who have provided personal and professional support throughout the thesis writing process. It is acceptable to use a more informal style and first-person pronouns than is typically permitted in academic writing. Acknowledgments are not considered part of the academic work itself; rather, they are an opportunity for you to express yourself in a more personal manner. The thesis acknowledgements should not exceed one page. Please refer to **Appendix I**.

### **3.10 Abstract**

A thesis abstract concisely summarises the research conducted by describing the objectives, methodology, significant findings, and conclusions of the study. It serves as a stand-alone representation, allowing readers to rapidly ascertain the thesis's essence and significance, thereby influencing their decision to investigate the document further. The abstract is instrumental in conveying the significance and contributions of the thesis to the academic community and broader audience.

In general, an abstract includes the following:

- (a) A brief theme sentence about the overall issue addressed in the thesis.

- (b) The main aim or purpose of the study.
- (c) The academic and practical importance of the study.
- (d) The methodology used in the study.
- (e) The main finding(s) of the study.
- (f) A concluding statement to indicate the contribution made by the study.
- (g) The practical or managerial implications of the study.

The abstract must consist of a single paragraph on one page. The length should be approximately 300-500 words. It should be indented and formatted with either single or 1.5 line spacing. The abstract must be composed in both English and Bahasa Melayu.

For a thesis written in Bahasa Melayu, the abstract must first be written in Bahasa Melayu and followed by an English translation. If the thesis is written in English, the abstract must be written in English and followed by a translation in Bahasa Melayu. Please refer to **Appendix J** and **Appendix K** for English and Malay abstract samples, respectively.

### **3.11 List of Tables**

This page lists all the tables in the thesis. The page number of the tables must also be included. The table numbers should be arranged according to chapters. Please refer to **Appendix M**.

### **3.12 List of Figures**

Figures include diagrams, photographs, illustrations, graphs, charts, and maps. The format of the list of figures should mirror that of the list of tables. Please refer to **Appendix N**.

### **3.13 List of Symbols/Abbreviations/Acronyms/Notations**

This page(s) should contain lists of all symbols, abbreviations, notations, and terminology contained in the text. They are listed in alphabetical order and are categorised as follows:

- (a) Roman alphabetic letters
- (b) Greek alphabetic letters
- (c) Superscripts
- (d) Subscripts

It is unnecessary to enumerate universally recognised scientific units such as *mm*, *cm*, and *ha*. Refer to **Appendix O** and **Appendix P** for abbreviations, acronyms and symbols respectively.

### **3.14 List of Appendices**

All appendices should be listed on this page. Please refer to **Appendix Q**.

### **3.15 Chapter Layout**

The thesis chapters and their sub-sections must be labelled and numbered. The chapters are numbered using Arabic numerals, for example, Chapter 1, Chapter 2, and

Chapter 3. The **subsections should not be indented** but should be arranged in a structured manner with no more than four levels as outlined below:

- 2 First level (Title of a chapter)
- 2.1 Second level (Title of a section)
- 2.1.1 Third level (Title of a subsection)
- 2.1.1.1 Fourth level (Title of a subsubsection)

Subsections beyond level four can be labelled using either Roman numerals or alphabets or headings without numbering. Refer to **Appendix R** for a sample of numbering, heading and sub-heading arrangement in a chapter.

### **3.16 Tables**

- (a) All tables must be numbered using Arabic numerals aligning with the chapter. For example, Table 2.1 is the first table that appears in Chapter 2.
- (b) All tables in the text as well as in the appendices should be referenced in the text.
- (c) Captions should be positioned at the top of the table (see Figure 3.1). Single-line captions should be centred while multiple-line captions should be left-indented.



Table 1.1      Title of the table		
Heading	Heading	Heading
1.	Text	Text
2.	Text	Text
3.	Text	Text

Source: Text

Figure 3.1      Arrangement of tables in the text.

- (d) Tables should be placed after the paragraph where they are first mentioned. If a table is very large and continues onto the next page, it can start on the next page after it is first mentioned.
- (e) A table may be placed in landscape orientation with its number and caption in a single space and placed above the table.
- (f) If the table occupies more than one page, the continued table on the following page should indicate that it is a continuation, for example: 'Table 3.7, continued'. The header row should also be repeated.
- (g) A reduced font size of between 10 and 11 may be used for text in the table.
- (h) Table sources and notes should be placed directly below the table with single spacing and a font size of 9.
- (i) The default setting for page numbers is applicable for pages with a table in portrait orientation. The page number should be located bottom–centre if the table is presented in landscape orientation.
- (j) The margin for a page with a table in landscape orientation is 3.25 cm from the top and bottom and 2.5 cm from the right and left margins.

### 3.17 Figures

- (a) Illustrations such as maps, charts, graphs, drawings, diagrams, and photographs are referred to as figures. All figures must be of high quality and legibility.
- (b) All figures must be numbered with respect to the chapter using Arabic numerals. For example, Figure 4.3 is the third figure that appears in Chapter 4.
- (c) All figures in the text as well as in the appendices must be referred to in the text.
- (d) A figure should be placed after the paragraph where it is first mentioned. If the figure is large, it can start on the next page after it is mentioned.
- (e) Figures captions, unlike text or tables, are placed at the bottom of the figure rather than at the top. Single-line captions should be centred while multiple-line captions should be left-indented.

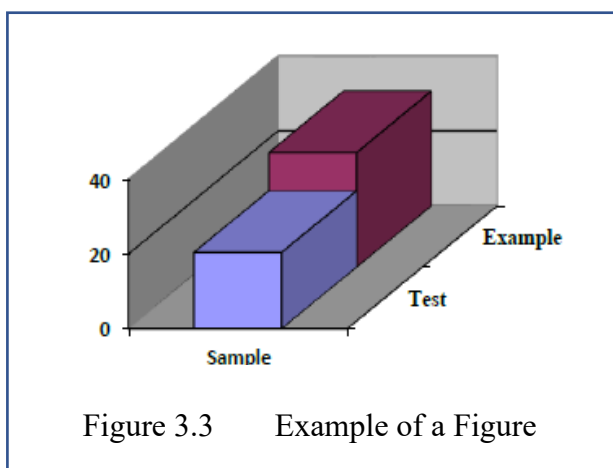


Figure 3.2 Arrangement of a Figure in the Text.

- (f) If the figure occupies more than one page, the continued figure on the following page should indicate that it is a continuation.

- (g) The default setting for page numbers is applicable for pages with figures presented in portrait orientation. The page number should be located at the bottom centre if a figure is presented in landscape orientation.
- (h) Oversized illustrations in the form of plans, maps, charts, graphs and others should be reduced to fit a single page unless the oversized materials are absolutely necessary for clarity. This oversized illustration should be submitted with CDs, slides or other suitable storage devices and placed in specially made pockets glued to the inner side of the back cover.
- (i) The margin for a page with a table in landscape orientation is 3.25 cm, while the top, bottom, right and left margins are 2.5 cm.
- (j) Using images and objects from other publications – If your thesis incorporates images, photos, maps, diagrams, et cetera not created by you, you must obtain copyright permission from the copyright holder of those works.

### 3.18 Equations

- (a) In general, all equations are considered as text. There are two types of mathematical equations: in-line equations and displayed and numbered equations.
- (b) **An in-line equation** is used for particularly simple relationships which (i) do not need vertical space for integrals, fractions, et cetera, (ii) can be expressed without breaking the flow of a sentence and (iii) will not be referenced again in the document. Figure 3.3 shows an example of an in-line equation.

If volume  $V$  and temperature  $T$  are known, the ideal gas law can be used to get a reasonable approximation for the pressure of a gas:  $P = nRT/V$ , where  $n$  is the number of moles of the gas and  $R$  is the gas constant.

Figure 3.3 Example of an in-line equation.

- (c) **Displayed and numbered equations** are used for equations where one often has to refer back. They are numbered according to the chapter. The equation incorporates the chapter number, for instance, (1.1), (2.3), (4.6), et cetera, and the equation numbering restarts at the beginning of each chapter.
- (d) A displayed and numbered equation number should be enclosed by parentheses and placed on the right-hand side of a page. See Figure 3.4 for an example of a displayed and numbered equation.
- (e) The equations that are written on a separate line should be centred and written consistently throughout the thesis.

<p>The non-relativistic Schrödinger equation for a particle of mass <math>m</math> subject to a potential energy function <math>V(x)</math> in a one-dimensional universe is</p> $\frac{-\hbar^2}{2m} \frac{d^2y}{dx^2} + V(x)y(x) = Ey(x), \quad (2.1)$ <p>where <math>\hbar = h/(2\pi)</math>, <math>h</math> is Plack's constant, and <math>E</math> is the total energy of the system.</p>
--

Figure 3.4 Sample of a displayed and numbered equation.

- (f) If a detailed derivation is needed, the derivation should be placed in an appendix.
- (g) For mathematical texts, the use of Equation Editor or LaTeX is advisable.
- (h) Mathematical parameters should be written in italics but units, numbers and mathematical functions such as logarithms should not be italicized.
- (i) The equations that are written on a separate line should be centred and written consistently throughout the thesis. Some equations are long and tend to be multi-line.
- (j) If an equation spans multiple lines, the lines should be aligned properly, and only one number should be used for the whole equation.
- (k) Equation numbers should be enclosed in parentheses and placed on the right-hand side of a page.

### 3.19 Footnotes

Footnotes should primarily be used to reference a text or an idea you have cited in your thesis. The use of footnotes should follow the format below:

- (a) Footnotes are numbered consecutively using Arabic numerals.
- (b) Footnotes appear on the bottom of the page that contains the sentence to which they refer.
- (c) Raised superscript numerals (example<sup>2</sup>) in the text referring to explanatory notes and documented sources must be placed at the bottom of the page as footnotes or at the end of the thesis as endnotes in a notes section.
- (d) Footnotes for references are formatted differently in terms of the author's name and the use of punctuation. The author's name should be written in full. A comma or a quotation mark should be used to separate the author's name, title of the article and publication details. The font size used should be two (2) points smaller than that used in the text. See Figure 3.5 for an example.

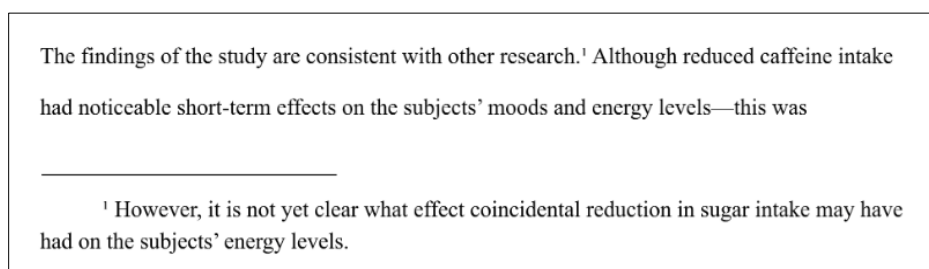


Figure 3.5 Example of a Footnote.

### 3.20 References

References are detailed descriptions of the sources from which information was obtained in preparing the thesis. All references must be listed at the end of the text. They should be arranged using one of the methods discussed in Chapter 4.

### **3.21 Appendix**

An appendix contains supplementary material that is not an essential part of the text but which may be helpful in providing a comprehensive understanding of the research problem. This material may include tables, charts, computer program listings, raw data, et cetera. Each appendix should be labelled with a specific title, for example, 'Appendix A' or 'Appendix B'.

### **3.22 List of Publications**

This section only lists all the published and accepted publications that have been authored/co-authored by the candidate and are related to his/her research. See **Appendix S**.

## CHAPTER 4

### REFERENCES, COPYRIGHT AND PLAGIARISM

#### 4.1 Introduction

Acknowledging your research sources correctly and explicitly is vital to maintaining academic honesty and effective communication. An acknowledgment may appear as in-text citations, footnotes, endnotes, or a bibliography. This chapter describes the format for referencing and in-text citations in your thesis.

#### 4.2 Formatting

References cited in the text should be presented in the List of References, which is placed at the end of the thesis. The style selected must be used consistently throughout the thesis. Each reference should be written in a single-spacing format and a double space should be left between references. The list of references must be arranged in alphabetical order, and the entries should not be numbered.

#### 4.3 Referencing Style

UTM accepts three reference styles for use in the thesis: the *Harvard system*, the *Vancouver system* and *The American Psychological Association*. The style selected must be used consistently throughout the thesis. Students are advised to check for the latest versions of reference styles, as these styles are frequently updated.

#### 4.4 Referencing Software

Using bibliographic management software can help you keep track of your references. It enables you to cite and make changes to different reference formats easily and correctly. UTM's library subscribes to Endnote referencing software for all students and staff. Students can download the software from ***myUTM*** portal. Once you log in to the portal, click on *Digital Experience > Software Centre* and click on the *Endnote icon* to download. Information about Endnote and its training session is available at <https://library.utm.my/research-2/turnitin-utm/>.

#### 4.5 Citing in Text

The purpose of citing in the text is to provide brief information about the source, allowing readers to find full details about the source in the reference list. Citations in the text must be written according to the styles selected. Two formats may be used for in-text citations:

- a. **(Author, Date)** – It is used to show the source of the information you are citing and is usually placed at the end of a sentence.

**Example:** Innovations could be adopted or rejected, (1) by an individual member of a system or (2) by the entire social system or (3) by relatively few individuals in the system who possess power, status, or technical expertise (Rogers, 2003; Bass, 1969)

- b. **Author (Date)** – It is used to emphasise the author by integrating the author's name into the sentence and is followed immediately by the date in brackets.

**Example:** In the long run, Saarinen (2006) argues, the development of tourism may not always be the most favourable use of natural and cultural resources ...



## **4.6 Third-Party Copyright Materials**

If a thesis includes copyright materials created by other people, often called third-party copyright materials, the student needs to seek permission from the copyright owners to use their work. However, there are certain circumstances in which students do not have to seek permission to use others' work, such as:

- (a) The work's copyright has expired.
- (b) The portion included is insubstantial, such as quotes from a book or journal article. Be careful when using quotes or excerpts from a short work such as a song, poem or musical composition, as small portions are unlikely to be considered insubstantial.
- (c) The materials have an expressed license that permits the use of the work, such as Creative Commons content, or the copyright owner has explicitly waived copyright.

Particular care should be taken if the thesis incorporates third-party music, sound recordings or films because obtaining the rights for such materials can be difficult. Please be reminded that you should refrain from using the materials without obtaining permission.

## **4.7 Seeking permission to use third-party copyright materials**

Students are encouraged to initiate the process of obtaining permission to use third-party copyright materials as soon as possible. Because obtaining permission is often a protracted and complex process, it is crucial to begin early. In some instances, obtaining permission may be impossible or a fee may be required.

All requests for permission must be submitted in writing. Students must maintain copies of all permission documents. These records are considered legal documents and should be kept for as long as the thesis is copyright protected or remains accessible to the public. Students may be required to provide copies of the permission documents if the university so requests.

#### **4.8 Plagiarism**

Plagiarism is a grave violation of research integrity that may result in dismissal. The Academic Rules of Graduate Studies (2020) of UTM define plagiarism as producing a thesis, dissertation, project report, article, coursework, or research findings without citing or acknowledging the original sources and asserting it as one's own work. Additionally, plagiarism includes submitting the entire or a portion of another person's work as one's own.

The library at UTM subscribes to Turnitin, a similarity-checking program that generates originality reports that detail the proportion of similarity between a student's writing and its sources. Before submitting their theses, students are required to run them through Turnitin and ensure that each chapter contains no more than 20% similarity. Information about the Turnitin software and training is available at <https://library.utm.my/research-2/turnitin-utm/>.

#### **4.9 Editing and Proofreading**

Editing and proofreading are important steps in thesis preparation. Editing is a process of adding to and refining what you have written. While editing, you should focus on at least four main areas:

**(a) Editing for content**

You should focus on the content of your thesis. Check whether the arguments in your thesis are clear and consistent. Also, ensure the connections between the paragraphs and sections are clear. Verify if your ideas are planned and presented in a logical order.

**(b) Editing for organisation and structure**

Always ensure the structure of your thesis is logical and flowing and develops your argument. Write using a logically ordered and sequenced plan that outlines the main ideas covered by each paragraph.

**(c) Editing for expression**

Use clear, concise and grammatically correct prose. Vary your sentence openings and structures.

**(d) Proofreading**

The final stage in the editing process is proofreading, which focuses on errors such as misspellings and mistakes in grammar and punctuation. It is recommended to proofread after completing the editing process.

When working with a proofreader, whether a professional or a friend, ensure that their suggestions do not significantly alter your work to the point where it loses its originality. Remember that proofreading can be quite labor-intensive, so if you're seeking assistance from a friend as a favor, be considerate of their time. Peer mentors, supervisors, or academic tutors are not responsible for providing proofreading services.

#### **4.10 The use of generative artificial intelligence (AI)**

Academic integrity serves as a fundamental principle in the field of research and academia. As a research student, it is imperative to develop your skills as an independent learner, researcher, and critical thinker. You must also uphold ethical and honest academic practices, show respect for the work of others, and ensure fair evaluation.

The rise of various AI tools has an impact on the student learning process including providing real time feedback on their work, providing recommendations tailored to the student's needs and suggestions to a wider range of resources. When utilizing AI tools to aid in the development of their work, students must properly acknowledging AI sources through appropriate referencing. Presently, there are limited guidelines for citation styles pertaining to generative AI technologies. In the absence of specific guidelines, it is advisable to treat information derived from AI as *personal communication*.

Additionally, it is important to acknowledge the utilization of AI and specify how and when it was employed to shape one's approach to the task or as part of the writing process.

## CHAPTER 5

### ELECTRONIC THESES AND DISSERTATIONS

#### 5.1 Introduction

Senate meeting No.01/2002/03 dated 12 June 2002 has decided that as a requirement for graduation, all postgraduate students should submit **one (1) hardcopy and a softcopy version of their thesis or dissertation or master's project report to the library.**

#### 5.2 Electronic Theses and Dissertation (ETD)

ETD is a database that stores the theses and dissertations of UTM graduates. The database is searchable via the Internet and helps increase the availability and utility of theses. UTM students and the public can access theses, dissertations and master's projects from the library website at <http://dms.library.utm.my:8080>. The electronic version must be the same as the final bound thesis approved by the Senate. If the status of a thesis is CONFIDENTIAL or RESTRICTED, an electronic version is still required but the status must be properly indicated in the *Thesis Status Declaration* form.

Once corrections and the abstract have been verified, students are required to submit **one (1) hardcopy and a softcopy version of their thesis or dissertations or master's project report to the library.** The faculty will then forward both the ETD and the hardbound manuscript to the library for archiving and access. An ETD must consist of two (2) files: pre-access and full-text files. Students will be required to submit the softcopy of the ETD files through the e-thesis system at the respective faculty.

### 5.2.1 Pre-Access File

The pre-access file is a document that contains information about the author, the panel of examiners and a summary of the thesis. By reading this file, a reader will be able to assess the relevance of the document to the reader's research interest. If readers wish to access the whole thesis, they should contact the librarian to obtain the full-text file. The pre-access file includes the first chapter of the bound thesis.

### 5.2.2 Full-Text File

A full-text file consists of all the contents of the thesis that has been approved by the senate. This file includes all preliminary pages, the main contents of the thesis and all appendices that were submitted to the panel of examiners and approved. The writing style of the original bound hardcopy must be retained as presented in chapters 1 to 4. All the pages of the full-text file must be saved into a single file.

### 5.2.3 Labelling the Pre-Access and Full-Text Files

Both the pre-access and full-text files should be named as follows:

**<name><matricno><p><tt><ss><c>.pdf**

where:

- a. <name> is the student's first name (without the surname or father's name)
- b. <matricno> is the student's matric card number or staff ID

c. <p> is the university where the thesis was submitted

- d – UTM
- l – other than UTM

d. <tt> is the year of approval

e. <ss> is the thesis status

- su – confidential
- th – restricted
- tt – open access

f. <c> is the file type

- p – pre-access file
- t – full-text file

*Example 1:* Wan Ahmad Nazri bin Wan Abdullah is a master's student at the Faculty of Engineering. His thesis was approved in 2002. His matric card number is MM100123. The thesis is declared restricted. Therefore, the file should be labelled as

<name> = wan ahmad nazri

<matricno> = mm100123

<p> = d

<tt> = 02

<ss> = th

The files should be named as follows:

wanahmadnazrimm100123d02thp.pdf      **(pre-access file)**

wanahmadnazrimm100123d02tht.pdf      **(full-text file)**

Example 2:

Wong Ah Seng is a UTM staff member who studied for his PhD overseas. The thesis was approved in the year 2002 and declared open access. He is a staff member of the Faculty of Social Sciences and Humanities, and his staff number is 1234.

Therefore, the file should be labelled as

<name> = wongahseng

<degree> = is derived as defined in Table 5.1 below

<Faculty> = is derived as defined in Table 5.1 below

<mode of study> = is derived as defined in Table 5.1 below

<matricno> = 1234

<p> = 1

<tt> = 02

<ss> = tt



Table 5.1 Degree, Faculty and Type of Study Codes

DEGREE	FACULTY	TYPE OF STUDY
P – Doctorate	A: Faculty of Civil Engineering	1 – course work
	B: Faculty of Electrical Engineering	
M – Master's	C: Faculty of Chemical and Energy Engineering	2 – course work and research
	D: Faculty of Mechanical Engineering	
U – Undergraduate	E: Faculty of Computing	3 – research
	F: Faculty of Built Environment and Surveying	
	G: Faculty of Science	
	H: Faculty of Social Sciences and Humanities	
	I: Azman Hashim International Business School	
	J: Malaysia Japan International Institute of Technology	
	K: Razak Faculty of Technology and Informatics	
	L: Faculty of Management	
	M: Other institutions	

The files should be named as follows:

wongahsengPB31234102ttp.pdf (pre-access file)

wongahsengPB31234102ttt.pdf (full texts file)

UTM staff studying in other universities are still required to submit an ETD to the library, and the file names for the above example should be as follows:

norfaezahPH37171101sup.pdf (Pre-access file)

norfaezahPH37171101sup.pdf (Full text file)

If the status of a thesis is CONFIDENTIAL or RESTRICTED, the pre-access file must contain only information that can be distributed. However, a full-text file is still required for archiving purposes.

**Appendix A Thesis Front Cover**

*5 cm*

TITLE IN CAPITAL LETTERS  
TITLE IN CAPITAL LETTERS  
TITLE IN CAPITAL LETTERS  
TITLE IN CAPITAL LETTERS

*3.25 cm*

*3.25 cm*

WAN ZUKI AZMAN WAN MUHAMAD

UNIVERSITI TEKNOLOGI MALAYSIA

*5 cm*

## Appendix B Declaration of Thesis/Dissertation/Project Form

PSZ 19:16 (Pind. 1/23)



### UNIVERSITI TEKNOLOGI MALAYSIA DECLARATION OF **Choose an item.**

Author's full name :

Student's Matric No. : Academic Session :

Date of Birth : UTM Email :

Choose an item. Title : TITLE IN CAPITAL LETTERS  
TITLE IN CAPITAL LETTERS  
TITLE IN CAPITAL LETTERS

I declare that this thesis is classified as:

**OPEN ACCESS**

I agree that my report to be published as a hard copy or made available through online open access.

**RESTRICTED**

Contains restricted information as specified by the organization/institution where research was done.  
*(The library will block access for up to three (3) years)*

**CONFIDENTIAL**

Contains confidential information as specified in the Official Secret Act 1972)

*(If none of the options are selected, the first option will be chosen by default)*

I acknowledged the intellectual property in the **Choose an item.** belongs to Universiti Teknologi Malaysia, and I agree to allow this to be placed in the library under the following terms :

1. This is the property of Universiti Teknologi Malaysia
2. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of only.
3. The Library of Universiti Teknologi Malaysia is allowed to make copies of this **Choose an item.** for academic exchange.

Signature of Student:

Signature :

Full Name

Date :

Approved by Supervisor(s)

Signature of Supervisor I:

Signature of Supervisor II

Full Name of Supervisor I  
NOOR HAZARINA HASHIM

Full Name of Supervisor II  
MOHD ZULI JAAFAR

Date :

Date :

NOTES : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction

## Appendix C Restricted and Classified Thesis Status Declaration Letter

This letter should be written by a supervisor and addressed to Perpustakaan UTM. A copy of this letter should be attached to the thesis.

Date:

Librarian

Jabatan Perpustakaan UTM,  
Universiti Teknologi Malaysia,  
Johor Bahru, Johor

Sir,

### **CLASSIFICATION OF THESIS AS RESTRICTED/CONFIDENTIAL**

**TITLE:** Click or tap here to enter text.

**AUTHOR'S FULL NAME:**Click or tap here to enter text.

Please be informed that the above-mentioned thesis titled \_\_\_\_\_ should be classified as RESTRICTED/CONFIDENTIAL for a period of three (3) years from the date of this letter. The reasons for this classification are

- (i)
- (ii)
- (iii)

Thank you.

Yours sincerely,

**SIGNATURE:**

**NAME:**

**ADDRESS OF SUPERVISOR:**

## Appendix D Declaration by Supervisor

“Choose an item. hereby declare that Choose an item. have read this Choose an item.  
and in Choose an item.  
opinion this Choose an item. is sufficient in term of scope and quality for the  
award of the degree of Choose an item.”

Signature : \_\_\_\_\_  
Name of Supervisor I : KHAIRUR RIJAL JAMALUDIN  
Date : 9 MAY 2017

Signature : \_\_\_\_\_  
Name of Supervisor II : NOOR HAZARINA HASHIM  
Date : 9 MAY 2017

Signature : \_\_\_\_\_  
Name of Supervisor III : MOHD ZULI JAAFAR  
Date : 9 MAY 2017

## Appendix E Declaration of Cooperation

### Declaration of Cooperation

This is to confirm that this research has been conducted through a collaboration [Click or tap here to enter text.](#) and [Click or tap here to enter text.](#)

Certified by:

Signature :  
Name :  
Position :  
Official Stamp  
Date

\* This section is to be filled up for theses with industrial collaboration

## Appendix F Certification of Examination

### Pengesahan Peperiksaan

Tesis ini telah diperiksa dan diakui oleh:

Nama dan Alamat Pemeriksa Luar :

Nama dan Alamat Pemeriksa Dalam :

Nama Penyelia Lain (jika ada) :

Disahkan oleh Timbalan Pendaftar di Fakulti:

Tandatangan :

Nama :

Tarikh :



**Appendix G Title Page**

*2.5 cm*

ON-LINE RECOGNITION OF DEVELOPING CONTROL CHART PATTERNS

TITLE

TITLE

TITLE

WAN ZUKI AZMAN WAN MUHAMAD

*3.25 cm*

*3.25 cm*

A Choose an item. submitted in Choose an item. of the  
requirements for the award of the degree of  
Choose an item.

Razak Faculty of Technology and Informatics  
Universiti Teknologi Malaysia

JUNE 2023

*2.5 cm*

**Appendix H Author's Declaration of Originality**

**DECLARATION**

I declare that this Choose an item. entitled "*title of the thesis*" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name :

Date : 10 NOVEMBER 2016

## Appendix I Acknowledgement

### ACKNOWLEDGEMENT

*4 lines spacing*

In preparing this thesis, I was in contact with many people, researchers, academicians, and practitioners. They have contributed towards my understanding and thoughts. In particular, I wish to express my sincere appreciation to my main thesis supervisor, Professor Dr. Mohd Shariff Nabi Baksh, for encouragement, guidance, critics and friendship. I am also very thankful to my co-supervisor Professor Dr. Awaluddin Mohd Shahrour and Associate Professor Dr. Hishamuddin Jamaluddin for their guidance, advices and motivation. Without their continued support and interest, this thesis would not have been the same as presented here.

I am also indebted to Universiti Teknologi Malaysia (UTM) for funding my Ph.D study. Librarians at UTM, Cardiff University of Wales and the National University of Singapore also deserve special thanks for their assistance in supplying the relevant literatures.

My fellow postgraduate student should also be recognised for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family member.

### ABSTRACT

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The purpose of this study is to investigate the application of genetic algorithm (GA) in modelling linear and non-linear dynamic systems and develop an alternative model structure selection algorithm based on GA. Orthogonal least square (OLS), a gradient descent method was used as the benchmark for the proposed algorithm. A model structure selection based on modified genetic algorithm (MGA) has been proposed in this study to reduce problems of premature convergence in simple GA (SGA). The effect of different combinations of MGA operators on the performance of the developed model was studied and the effectiveness and shortcomings of MGA were highlighted. Results were compared between SGA, MGA and benchmark OLS method. It was discovered that with similar number of dynamic terms, in most cases, MGA performs better than SGA in terms of exploring potential solution and outperformed the OLS algorithm in terms of selected number of terms and predictive accuracy. In addition, the use of local search with MGA for fine-tuning the algorithm was also proposed and investigated, named as memetic algorithm (MA). Simulation results demonstrated that in most cases, MA is able to produce an adequate and parsimonious model that can satisfy the model validation tests with significant advantages over OLS, SGA and MGA methods. Furthermore, the case studies on identification of multivariable systems based on real experiment data from two systems namely a turbo alternator and a continuous stirred tank reactor showed that the proposed algorithm could be used as an alternative to adequately identify adequate and parsimonious models for those systems. Abstract must be bilingual. For a thesis written in Bahasa Melayu, the abstract must first be written in Bahasa Melayu and followed by the English translation. If the thesis is written in English, the abstract must be written in English and followed by the translation in Bahasa Melayu. The abstract should be brief, written in one paragraph and not exceed one (1) page. An abstract is different from synopsis or summary of a thesis. It should states the field of study, problem definition, methodology adopted, research process, results obtained and conclusion of the research. The abstract can be written using single or one and a half spacing. Example can be seen in Appendix 1 (Bahasa Melayu) and Appendix J (English).

### ABSTRAK

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Kajian ini dilakukan bertujuan mengkaji penggunaan algoritma genetik (GA) dalam pemodelan sistem dinamik linear dan tak linear dan membangunkan kaedah alternatif bagi pemilihan struktur model menggunakan GA. Algoritma kuasa dua terkecil ortogon (OLS), satu kaedah penurunan kecerunan digunakan sebagai bandingan bagi kaedah yang dicadangkan. Pemilihan struktur model menggunakan kaedah algoritma genetik yang diubahsuai (MGA) dicadangkan dalam kajian ini bagi mengurangkan masalah konvergensi pramatang dalam algoritma genetik mudah (SGA). Kesan penggunaan gabungan operator MGA yang berbeza ke atas prestasi model yang terbentuk dikaji dan keberkesanan serta kekurangan MGA ditandakan. Kajian simulasi dilakukan untuk membandingkan SGA, MGA dan OLS. Dengan menggunakan bilangan parameter dinamik yang setara kajian ini mendapati, dalam kebanyakan kes, prestasi MGA adalah lebih baik daripada SGA dalam mencari penyelesaian yang berpotensi dan lebih berkebolehan daripada OLS dalam menentukan bilangan sebutan yang dipilih dan ketepatan ramalan. Di samping itu, penggunaan carian tempatan dalam MGA untuk menambah baik algoritma tersebut dicadangkan dan dikaji, dinamai sebagai algoritma memetik (MA). Hasil simulasi menunjukkan, dalam kebanyakan kes, MA berkeupayaan menghasilkan model yang bersesuaian dan parsimoni dan memenuhi ujian pengesahan model di samping memperoleh beberapa kelebihan dibandingkan dengan kaedah OLS, SGA dan MGA. Tambahan pula, kajian kes untuk sistem berbilang pemboleh ubah menggunakan data eksperimental sebenar daripada dua sistem iaitu sistem pengulang-alik turbo dan reaktor teraduk berterusan menunjukkan algoritma ini boleh digunakan sebagai alternatif untuk memperoleh model termudah yang memadai bagi sistem tersebut.

## Appendix L Table of Contents

<b>TABLE OF CONTENTS</b>		
		<i>4 lines spacing</i>
<b>TITLE</b>		<b>PAGE</b>
<b>DECLARATION</b>		<b>iii</b>
<b>ACKNOWLEDGEMENT</b>		<b>iv</b>
<b>ABSTRACT</b>		<b>v</b>
<b>ABSTRAK</b>		<b>vi</b>
<b>TABLE OF CONTENTS</b>		<b>vii</b>
<b>LIST OF TABLES</b>		<b>ix</b>
<b>LIST OF FIGURES</b>		<b>x</b>
<b>LIST OF ABBREVIATIONS</b>		<b>xi</b>
<b>LIST OF SYMBOLS</b>		<b>xii</b>
<b>LIST OF APPENDICES</b>		<b>xiii</b>
<b>CHAPTER 1 INTRODUCTION</b>		<b>1</b>
1.1	Problem Background	1
1.2	Problem Background	1
1.3	Problem Statement	2
1.4	Research Goal	2
1.4.1	Research Objectives	2
1.5	Captions	3
1.6	Quotation	4
1.7	Equation	4
<b>CHAPTER 2 LITERATURE REVIEW</b>		<b>7</b>
2.1	Introduction	7
2.1.1	State-of-the-Arts	8
2.2	Limitation	8
2.3	Research Gap	8
<b>CHAPTER 3 RESEARCH METHODOLOGY</b>		<b>11</b>
3.1	Introduction	11

3.1.1	Proposed Method	11
3.1.1.1	Research Activities	11
3.2	Tools and Platforms	12
3.3	Chapter Summary	12
<b>CHAPTER 4</b>	<b>PROPOSED WORK</b>	<b>13</b>
4.1	The Big Picture	13
4.2	Analytical Proofs	13
4.3	Result and Discussion	14
4.4	Chapter Summary	14
<b>CHAPTER 5</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>17</b>
5.1	Research Outcomes	17
5.2	Contributions to Knowledge	17
5.3	Future Works	17
<b>REFERENCES</b>		<b>19</b>
<b>LIST OF PUBLICATIONS</b>		<b>24</b>

## Appendix M List of Tables

### LIST OF TABLES

*4 lines spacing*

<b>TABLE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Table 1.1	The role of statistical quality engineering tools and methodologies	4
Table 1.2	Basic ANN models used for control chart pattern recognition	4
Table 2.1	Regression analysis for the results of preliminary feature screening	7
Table 2.2	Estimated effects and regression coefficients for the recogniser's performance (reduced model)	7
Table 5.1	Example Repeated Header Table	17



## Appendix N List of Figures

### LIST OF FIGURES

*4 lines spacing*

<b>FIGURE NO.</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 1.1	Trends leading to the problem using MZJ Formatting Method	3
Figure 1.2	Design and development phases of the proposed scheme (Muhamad, 2018)	3
Figure 2.1	Continuous variability reduction using SPC chart (Revelle and Harrington, 1992)	7
Figure 2.2	Typical fully developed patterns on Shewhart control chart (Cheng, 1989)	7
Figure 3.1	Example of Formatting Method	12
Figure 4.1	This is MZJ original idea	13
Figure 4.2	The method for hig performance formatting	14

## Appendix O List of Abbreviations/Acronyms

### LIST OF ABBREVIATIONS


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ANN	-	Artificial Neural Network
BA	-	Bees Algorithm
GA	-	Genetic Algorithm
MTS	-	Mahalanobis Taguchi System
MD	-	Mahalanobis Distance
OA	-	Orthogonal Array
PSO	-	Particle Swarm Optimization
TM	-	Taguchi Method
UTM	-	Universiti Teknologi Malaysia
XML	-	Extensible Markup Language

## Appendix P List of Symbols

### LIST OF SYMBOLS

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$\delta$	-	Minimal error
$D, d$	-	Diameter
$F$	-	Force
$v$	-	Velocity
$p$	-	Pressure
$I$	-	Moment of Inertia
$r$	-	Radius
Re	-	Reynold Number

## Appendix Q List of Appendices

<b>LIST OF APPENDICES</b>		
<b>APPENDIX</b>	<b>TITLE</b>	<b>PAGE</b>
Appendix A	Mathematical Proofs	21
Appendix B	Psuedo Code	22
Appendix C	Time-series Results Long Long Long Long Long Long Long Long Long Long	23

**CHAPTER 1**

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**INTRODUCTION (Heading 1)**

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**1.1 Problem Background (Heading 2)**

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**1.2 Problem Background**

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### **1.3 Problem Statement**

### **1.4 Research Goal**

#### **1.4.1 Research Objectives**

The objectives of the research are :

- (a) To estimate the parameters
- (b) Item 1
- (c) Item 2
- (d) To define the best parameter estimate.

**LIST OF PUBLICATIONS**

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