THESIS PREPARATION

SCHOOL OF GRADUATE STUDIES
UNIVERSITI TEKNOLOGI MALAYSIA
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<td>3.13.7</td>
<td>References</td>
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<td>3.13.8</td>
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LIST OF EDITORS

The editorial members of the 2018 edition of UTM Thesis Manual are:

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Dr. Mahadi Bin Bahari

Dr. Nur Hafizah Binti Abd Khalid

Pn. Junaidah Binti Abdullah

Pn. Siti Nisrin Binti Mohd Anis

En. Wan Zuki Azman Bin Wan Muhamad
The UTM Thesis Manual is prepared to guide postgraduate students of UTM for the submission of their thesis and dissertation. The guide covers the technical and language aspects related to thesis writing, which includes language to be used, typeface, font size, spacing, pagination, units, chapter format and references style. The guide is divided into five chapters that explain the above information and submission options to be followed by all postgraduate students in Universiti Teknologi Malaysia. This new edition comes with a fresh look. In our effort to reduce paper use and to support sustainable practices, UTM theses are now printed on double-sided. Apart from updating, general editing and refinement of the contents, then contents were re-arranged for easier search.

This guide serves as the ‘in-house style’ for all UTM theses. All the best!
CHAPTER 1

ORGANIZATION OF THESIS

1.1 Introduction

Thesis in this manual refers to a scientific documented report of original research conducted by a student in an ethical and professional manner for fulfilment of the requirement for a postgraduate degree. The thesis should be presented in a manner that will reflect credit on the student, the faculty, and the University.

1.2 Types of Thesis Format

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

(a) Conventional format

(b) Article style format (by publications)

A thesis is made up of three main parts namely preliminary pages, main body and supplementary. The following sections provide guideline for postgraduate candidates in writing and preparing their thesis and dissertation.

1.2.1 Conventional Format

The conventional format as shown in Table 1.1 is the most common form of research project/dissertation/thesis used by most candidates.
### Table 1.1 The General Structure for Conventional Thesis Format

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>STATUS</th>
<th>EXAMPLE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front Cover page</td>
<td>Compulsory</td>
<td>Appendix A</td>
<td>For viva only. Without page number</td>
</tr>
<tr>
<td>Blank Page</td>
<td>Compulsory</td>
<td></td>
<td>Without page number</td>
</tr>
<tr>
<td>Declaration of Thesis</td>
<td>Compulsory</td>
<td>Appendix B</td>
<td>Without page number</td>
</tr>
<tr>
<td>Letter regarding status classification of thesis</td>
<td>Compulsory</td>
<td>Appendix C</td>
<td>Required if thesis is classified as ‘Restricted’</td>
</tr>
<tr>
<td>Supervisor’s declaration</td>
<td>Compulsory</td>
<td>Appendix D1</td>
<td>Without page number</td>
</tr>
<tr>
<td>Declaration on cooperation</td>
<td>Compulsory</td>
<td>Appendix D2</td>
<td>Without page number</td>
</tr>
<tr>
<td>Certification of examination</td>
<td>Compulsory</td>
<td>Appendix D2</td>
<td>Without page number</td>
</tr>
<tr>
<td>Title Page</td>
<td>Compulsory</td>
<td>Appendix E</td>
<td>Counted as (i) but page number does not appear.</td>
</tr>
<tr>
<td>Author’s Declaration Page</td>
<td>Compulsory</td>
<td>Appendix F</td>
<td>Roman, (ii)</td>
</tr>
<tr>
<td>Dedication</td>
<td>Optional</td>
<td>Appendix G</td>
<td>Roman (if any)</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>Optional</td>
<td>Appendix H</td>
<td>Roman (if any)</td>
</tr>
<tr>
<td>Abstract</td>
<td>Compulsory</td>
<td>Appendix I</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>Abstrak</td>
<td>Compulsory</td>
<td>Appendix J</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>Compulsory</td>
<td>Appendix K</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>List of Tables</td>
<td>Compulsory</td>
<td>Appendix L</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>List of Figures</td>
<td>Compulsory</td>
<td>Appendix M</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>Compulsory</td>
<td>Appendix N</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>List of Symbols</td>
<td>Compulsory</td>
<td>Appendix O</td>
<td>Continuing from the previous Roman number</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>Compulsory</td>
<td>Appendix P</td>
<td>Continuing from the previous Roman number</td>
</tr>
</tbody>
</table>

#### MAIN BODY

<p>| Chapter 1: Introduction                      | Compulsory | Appendix Q | Arabic, start at (1) and appear                             |</p>
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Compulsory</th>
<th>Optional</th>
<th>Appendix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 2: Literature Review</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapter 3: Methodology</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapter 4: Results</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapter 5: Discussion</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapter 6: Conclusion</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Depending on the needs, some thesis might combine Chapter 5 & 6.

**SUPPLEMENTARY**

<table>
<thead>
<tr>
<th>Appendices</th>
<th>Optional</th>
<th>Appendix</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Publications and Papers Presented</td>
<td>Optional</td>
<td>Appendix U</td>
</tr>
</tbody>
</table>

**1.2.2 Thesis by Publications**

UTM also accept the presentation of thesis/dissertation in the format of published papers, where such papers have been published by indexed journals during the period of candidature. Papers submitted as a PhD thesis must be based on a particular theme/focus and form a cohesive research write up for the degree. Each article should address a specific research objective or a related topic of the study. Table 1.2 presents the general structure for thesis/dissertation by publications.
Table 1.2  The General Structure for Thesis By Publications

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>STATUS</th>
<th>EXAMPLE</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Compulsory</td>
<td>Appendix A</td>
<td>For viva only. Without page number</td>
</tr>
<tr>
<td>Blank Page</td>
<td>Compulsory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declaration of Thesis</td>
<td>Compulsory</td>
<td>Appendix B</td>
<td>Without page number</td>
</tr>
<tr>
<td>Letter regarding status classification of thesis</td>
<td>Compulsory</td>
<td>Appendix C</td>
<td>Required if thesis is classified as</td>
</tr>
<tr>
<td>Supervisor’s declaration</td>
<td>Compulsory</td>
<td>Appendix D1</td>
<td>Without page number</td>
</tr>
<tr>
<td>Declaration on cooperation</td>
<td>Compulsory</td>
<td>Appendix D2</td>
<td>Without page number</td>
</tr>
<tr>
<td>Certification of examination</td>
<td>Compulsory</td>
<td>Appendix D2</td>
<td>Without page number</td>
</tr>
<tr>
<td>Title Page</td>
<td>Compulsory</td>
<td>Appendix E</td>
<td>Counted as (i) but page number does not</td>
</tr>
<tr>
<td>Author’s Declaration Page</td>
<td>Compulsory</td>
<td>Appendix F</td>
<td>Roman, (ii)</td>
</tr>
<tr>
<td>Dedication</td>
<td>Optional</td>
<td>Appendix G</td>
<td>Roman (if any)</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>Optional</td>
<td>Appendix H</td>
<td>Roman (if any)</td>
</tr>
<tr>
<td>Abstract</td>
<td>Compulsory</td>
<td>Appendix I</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>Abstrak</td>
<td>Compulsory</td>
<td>Appendix J</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>Compulsory</td>
<td>Appendix K</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>List of Tables</td>
<td>Compulsory</td>
<td>Appendix L</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>List of Figures</td>
<td>Compulsory</td>
<td>Appendix M</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>List of Equations</td>
<td>Compulsory</td>
<td>Appendix N</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>List of Symbols/Abbreviations/Notations/</td>
<td>Compulsory</td>
<td>Appendix O</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td>List of Appendices</td>
<td>Compulsory</td>
<td>Appendix P</td>
<td>Continuing from the previous Roman</td>
</tr>
<tr>
<td><strong>MAIN BODY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chapter 1: Introduction and Thesis Overview</td>
<td>Compulsory</td>
<td>Appendix Q</td>
<td>Arabic, start at (1) and appear</td>
</tr>
</tbody>
</table>
Chapter 1 introduces the thesis. A full explanatory overview is required to link the published papers to the research thesis. This may include sections on overview of the thesis, problem background, problem statement, objectives, research scope and organization of the thesis. In chapter 2, students are required to review related literature particularly ones that is not covered in-depth within the papers. Chapter 3 describes the findings from Article 1. The findings must relate with the problem statement and research objectives highlighted in Chapter 1. The format applies for Chapter 4 and 5. Finally, Chapter 6 summarizes the findings from the three publications, overview of the important contributions of your work, suggests academic and practical implications resulting from your findings and future research suggestion.

Candidate must obtain the consent from other co-authors for all papers used as part of their PhD thesis. The consent can be in the form of verification from the journal publisher or letter or email communication with the co-authors. A clear statement of the contribution made by each author in any joint published work is required and should be included in as one of the
appendix. For example, a statement of contribution from a three-author academic research publication is as follows:


**Statement of Contributions:** Wong, A.N.C. participated in all experiments, coordinated the data analysis and contributed to the writing of the manuscript. Ismail, M. supervised the development of work and edited the manuscript. Hashim, N.H. gave technical support, conceptual advice, and helped in data interpretation.

The format specifications of the thesis/dissertation must conform to the requirement as outline in Chapter 2.
CHAPTER 2

GENERAL REQUIREMENTS

2.1 Introduction

This chapter will explain the formatting requirements and writing conventions that need to be observed in preparation of UTM thesis.

2.2 Language

The thesis may be written either in English, Bahasa Melayu or Arabic (applicable only to candidates from School of Islamic Civilization, Faculty of Social Science and Humanities). Language use and terms of spelling (American or British) should be consistent throughout the thesis. The Roman alphabet should be use unless otherwise required by the discipline.

2.3 Printing

The thesis must be printed on a laser printer. Either single or double-sided text is permitted for submission of thesis for oral examination purposes. When producing double-sided text, please take particular care to fulfil all the requirements specified in these regulations, e.g. pagination and margin widths. Mixtures of single and double-sided text are not acceptable. However, the final hardbound thesis should be printed using double-sided text.

2.4 Thesis title

The thesis title must adhere to the following guidelines:
• The title should be a clear and concise description of the focus and contribution of the research. It should not contain more than 15 words and excludes grammatical words such as articles, conjunction and prepositions.

• The title should not contain phrases which reflect research exercise such as “An investigation of …”, “A preliminary study of …”, “A study of …”, “Analysis of …”, “On the …”, “Theory of …”, “Some….”, and “Toward a …”.

• The title should not contain formulas, symbols or subscripts, Greek letters, or other non-alphabetical symbols. Word substitutes should be used instead.

• Thesis title should not contain acronyms or even acronyms in brackets except for commonly used in the field of the study (eg: DNA, GPS). For example, “GIS” should be written as “Geographical Information System” and should not be written as “Geographical Information System (GIS)”.

• Thesis title should not contain punctuations such as colon “:”, semi-colon “;”, etc. except commas “,” when necessary.

2.5 Number of Pages

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

- Bachelor Degree Project Report : 100 pages
- Doctorate Thesis : 300 Pages

These limits include tables, figures and other illustrations in the text but do not include Appendices.
2.6 Page Layout

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

2.7 Type of Paper

White simile 80 gsm (grams per square meter) high-quality A4 size (for viva-voce) papers (210 x 297 mm) and B5 size (for final bound copies) must be used. 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. Font type and size that are commonly used for printed academic materials should be used (i.e: Times New Roman, Tahoma, Arial, Book Antiqua. The same font type should be used throughout the thesis. The character size should not be less than 0.2 cm for capital letters and 0.15 cm for small letters. If Microsoft Words is used, font type Times New Roman with font size 12 or bigger should be used. One and a half line spacing should be used.

2.9 Margins

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

2.10 Spacing

The following guidelines should be observed:

i. The spacing between the chapter number and the title follow three times SHIFT+ENTER spacing.
ii. The spacing between the title and the first line of a text should be four (4) line spacing;

iii. The spacing between the last line of a text with the title of a sub-section should be four (4) line spacing;

iv. The spacing between the title of a sub-section and the first line of a text should be two (2) line spacing;

v. The spacing between paragraphs should be two (2) line spacing;

vi. The number and the title of sub-section should be aligned with the left margin;

vii. The first line of a paragraph should be indented by 1.27 cm (0.5 inch) from the left margin;

viii. A new paragraph should not begin on the last line of a page;

ix. The spacing between the last line of a text and a table, or a figure or an illustration should be two (2) line spacing;

x. The spacing after a comma (,) should be one (1) character spacing.

2.11 Pagination

Each page of a thesis must be counted and numbered. Pages should be numbered consecutively as shown in Table 1.1. The page numbers should be printed at the bottom centre, 1.25 cm from the bottom edge. Numbering should be as follows:

i. Preliminary pages of a thesis, starting from the title page should be numbered using small letter Roman numeric (i, ii, iii, etc.); the texts should be numbered using Arabic numeric (1, 2, 3, etc.).

ii. The first page should be the title page. This page should be counted "i" but should not be printed.

iii. The first page of each chapter should be counted and the page number should be printed and placed at odd page.

iv. If a thesis is made up of several parts, separating pages can be inserted but these pages should not be counted and numbered.
v. If a chapter ended with an odd page number, a separate blank page should be added and counted, but the page number should not be printed. (In MS Word, insert Section Breaks Odd Page under Layout Tab)

### 2.12 Binding

Students are required to ensure that all university requirements have been met and necessary signatures have been obtained before binding of the thesis. **Starting from 1st September 2018,** the final bound copies of the thesis must be submitted in B5 size and printed on both sides on 80gm paper. A cover of the thesis and its detail are as follows:

**Figure 2.1 Thesis Cover Details for Master’s Degree**

<table>
<thead>
<tr>
<th><strong>Size</strong></th>
<th>B5</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
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</tr>
<tr>
<td><strong>RGB Code</strong></td>
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</tr>
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</tr>
<tr>
<td><strong>Type of Paper</strong></td>
<td>80gsm</td>
</tr>
<tr>
<td><strong>Printing</strong></td>
<td>Double Sided</td>
</tr>
</tbody>
</table>
**Figure 2.2** Thesis Cover Details for Doctor of Philosophy Degree

<table>
<thead>
<tr>
<th>Cover of the Thesis</th>
<th>Hardcover Perfect: Holland Art Paper + Laminate + Glossy</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th><strong>Size</strong></th>
<th>B5</th>
</tr>
</thead>
<tbody>
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<td>Dark Red</td>
</tr>
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<td>#5C001F</td>
</tr>
<tr>
<td><strong>RGB Code</strong></td>
<td>R92G0B3</td>
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<td>1400gsm</td>
</tr>
<tr>
<td><strong>Type of Paper</strong></td>
<td>80gsm</td>
</tr>
<tr>
<td><strong>Printing</strong></td>
<td>Double Sided</td>
</tr>
<tr>
<td><strong>Cover of the Thesis</strong></td>
<td>Hardcover Perfect: Holland Art Paper + Laminate + Glossy</td>
</tr>
</tbody>
</table>
CHAPTER 3

THESIS FORMAT

3.1 Declaration of Thesis

Thesis status declaration is completed using the Thesis Status Declaration form issued by Perpustakaan UTM form (see Appendix B). If the thesis is declared as ‘CONFIDENTIAL’ or ‘RESTRICTED’, a letter from the party classifying the information as confidential or restricted must be attached (see Appendix C). The letter should clearly indicate:

(i) The reasons for classification

(ii) The duration for classification

The typical duration for confidential or restricted classification is three (3) years. A thesis can be classified as confidential or restricted up to a maximum period of five (5) years. Examples can be seen in Appendices A and B.

If the status declaration form is not submitted or the form is incomplete, the University will assume the thesis is unrestricted and the thesis shall be made available for distribution as published academic exchange materials.

3.2 Declaration

3.2.1 Supervisor's Declaration

A thesis to be submitted for the purpose of examination must obtain prior declaration by the supervisor on the standard and quality of the thesis. See example in Appendix D1.
3.2.2 Declaration on Cooperation with Outside Agencies and Certification of Examination

This section consists of two parts. Part A includes any cooperation with other outside agencies in carrying out the research project that lead to the submission of the thesis must be declared. In Part B, students must obtain certification of examination from the School of Graduate Studies (see example in Appendix D2).

3.3 Title Page

Title page must contain information listed in the following order:

- Title of the thesis;
- Student’s full name as in identity card or passport for international student;
- Statement of award for the thesis (see Section 3.3.2);
- Name of School (if applicable) where the student registered;
- Name of Faculty/School where the student registered;
- Name of the University; and
- Month and Year of submission (Month and Year of submission of hard bound copy of the thesis).
- Example (see Appendix E)

3.3.1 Thesis Title

The thesis title must adhere to the following guidelines:

- The title should be a clear and concise description of the focus and contribution of the research. It should not contain more than 15 words and excludes grammatical words such as articles, conjunction and prepositions.

- The title should not contain phrases which reflect research exercise such as “An investigation of …”, “A preliminary study of …”, “A study of …”, “Analysis of …”, “On the …”, “Theory of …”, “Some….”, and “Toward a …”.


• The title should not contain formulas, symbols or subscripts, Greek letters, or other non-alphabetical symbols. Word substitutes should be used instead.

• Thesis title should not contain acronyms or even acronyms in brackets except for commonly used in the field of the study (e.g: DNA, GPS). For example, “GIS” should be written as “Geographical Information System” and should not be written as “Geographical Information System (GIS)”.

• Thesis title should not contain punctuations such as colon “:”, semi-colon “;”, etc. except commas “,” when necessary.

3.3.2 Statement of Award for the Thesis

This statement should be written on the Title Page. It should state the purpose and the award for which the thesis is submitted. Examples of statements for various purposes and awards are listed below:

1. Bachelor’s Degree Project Report

A report submitted in partial fulfilment of
the requirements for the award of the degree of
Bachelor of ............................................

2. Master's Project Report (By course work)

A project report submitted in partial fulfilment of
the requirements for the award of the degree of
Master of ....................... (specialisation)

3. Master's Dissertation (By coursework and research)

A dissertation submitted in partial fulfilment of
the requirements for the award of the degree of
Master of ....................... (specialisation)
4. Master's Thesis (By research)

A thesis submitted in fulfilment of the requirements for the award of the degree of Master of ................. (specialisation)

5. Doctor of Philosophy Thesis

A thesis submitted in fulfilment of the requirements for the award of the degree of Doctor of Philosophy (specialisation)

6. Engineering Doctorate Thesis

A dissertation submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Engineering (specialisation)

3.4 Declaration Page

This page should contain declaration by the student on originality of the thesis. The declaration should be signed. See example in Appendix F.

3.5 Dedication Page (optional)

The dedication must be brief, not more than one paragraph, and must not contain any number, chart or photograph. See example in Appendix G.

3.6 Acknowledgement (optional)

The student may acknowledge the assistance of various individuals or organisations in successfully producing the thesis. This should be written in one page. Example can be seen in Appendix H.
3.7 **Abstract**

An abstract is a short summary of the thesis. The abstract should include the followings:

- The abstract has to start with a brief theme sentence to orientate the reader about the overall issue addressed in the thesis.
- The abstract should indicate the aim or purpose of the research.
- The academic and/or practical importance of the study should be explained.
- The methodology used in the study should also be briefly described.
- The main findings of the study should be summarized.
- A statement of conclusion should indicate the contribution made by the study on filling gaps in the literature.
- The practical or managerial implications of the study’s findings should be highlighted where appropriate.
- 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 written in one paragraph and not exceed one (1) page.
- The abstract can be written using single or 1.5 spacing.

Example can be seen in Appendix I (English) and Appendix J (Bahasa Melayu).

3.8 **Table of Contents Page**

The Table of Contents page must start on a new page. It should list all sections, chapters and maximum of four sub-headings. The titles must be written using the same words as those written in the text. See example in Appendix K.
3.9 List of Tables

This page should list all the tables found in the thesis. The page number of the table must also be included. The table numbers should be arranged according to the chapters. See example in Appendix L.

3.10 List of Figures

Diagrams, photographs, drawings, graphs, charts and maps are included as figures. The list should be written similar as the List of Tables. See example in Appendix M.

3.11 List of Symbols/Abbreviations/Notations/Terminology

All symbols or abbreviations or notations or terminology found in the text should be listed on this page. They are listed in the following alphabetical order:

- Roman letters alphabetically
- Greek letters alphabetically
- Superscripts
- Subscripts

Universally recognised scientific symbols such as mm, cm, Ha need not be listed. See example in Appendix N and Appendix O respectively.

3.12 List of Appendices

All appendices should be listed on this page. See example in Appendix P.
3.13 Body

3.13.1 Chapter Layout

A thesis must be divided into chapters. A title must be given and it should reflect its content. A new chapter must begin on a new page. A chapter must be divided into sections. These sections must be given appropriate titles and numbered.

Texts must be written in paragraphs. Long paragraphs should be avoided. Each paragraph must describe an issue or subject. There must be continuity between paragraphs. The text should contain:

i. An introduction and background on the study or research;

ii. A detailed description of the study or research which include theories, model and materials and methods used;

iii. The data collection and analysis techniques.

iv. The main results and discussions; and

v. The conclusions and significance of the findings.

All chapters and their sub-sections must be labelled and numbered. The chapters are numbered using Arabic numeric, i.e. Chapter 1, Chapter 2, Chapter 3, and so on. The sub-sections should not be indented but arranged in a structured manner not more than four levels as follows:

2 First level (Title of the chapter)

2.1 Second level (Title of the sub-section)

2.1.1 Third level (Title of the sub-sub-section)

2.1.1.1 Fourth level (Title of the sub-sub-sub-section)

If the length of a title of a chapter or any level is more than one line, same line spacing as in the text should be used. Sub-sections beyond level four should be labelled using characters. (eg. a, i, etc)
3.13.2 Citation in Text

Citation is a means of formally recognizing within the text, the resources from which the information or idea were obtained. The purpose is to acknowledge the work of others, to demonstrate the body of knowledge in which the work is based on and to lead others for further information.

Citation in the texts must be written according to any one of the styles described in Chapter 4. The use of software such as RefWorks, JabRef, Mendeley or EndNote for publishing and managing citation and references is encouraged. At the end of the thesis, students must supply list of references in alphabetical order by author, with consistent punctuation.

3.13.2.1 Direct Quotations in the Text

A direct quotation must be written in a separate paragraph. If the quotation is in a different language, it must be written in italic. Indented quotation should be single spaced with no quotation marks with 1.27 cm left and right indentation respectively. Example of writing a quotation is shown in Appendix S.

3.13.3 Tables in the Text

- All tables must be numbered using Arabic numeric and numbered with respect to the chapter. For example, Table 4.3 is the third table that appears in chapter 4.
- Students need to ensure that all tables shown in the thesis as well as in the Appendices are referred to in the text.
- A table should be on the page following the first reference to it or placed as close as possible to the original text reference. Text material should highlight analysis or findings, summarizing only important details rather than reiterating the entire table.
• A caption should be positioned at the top of the table. If the caption is written in a single line, it should be centered. If the caption is written more than one line, it should be left indented.
• Tables may be placed in landscapeed orientation; in such cases, the table number, title and caption should be single-spaced and placed above the table.
• If the Table occupies more than one page, it must repeat the header rows on the next page.
• Table sources and notes should be placed directly below the table.
• Smaller font may be used for text in the table.
• The default setting for page number is applicable for page with Table presented in portrait orientation (See Appendix S1). Page number should be located bottom-center (right side in portrait) if Table is presented in landscape orientation (See Appendix S2).
• The margin for page with Table in landscape orientation is 3.25 cm while from the top and bottom, right and left margin is 2.5cm.
• Table sources and notes should be placed directly below the table. If a table has been adapted from a source, indicate using “Adapted from…”.

3.13.4 Figures in the Text

• Illustrations such as maps, charts, graphs, drawings, diagrams, and photographs are referred as figures. All figures must be clear and of high quality.
• All figures must be numbered using Arabic numeric and numbered with respect to the chapter. For example, Figure 4.3 is the third figure that appears in chapter 4.
• Students need to ensure that all figures shown in the thesis as well as in the Appendices are referred to in the text.
• A figure should be on the page following the first reference to it or placed as close as possible to the original text reference. Text material should highlight analysis or findings, summarizing only important details rather than reiterating the figure.
• A caption should be positioned at the bottom of the figure. If the caption is written in a single line, it should be centered. If the caption is written more than one line, it should be left indented.
- Figure should conform to standard margin requirements.
- If the figure occupies more than one page, the continued figure on the following page should indicate that it is a continuum.
- All figures in the chapter can also be grouped together and positioned at an appropriate location.
- The default setting for page number is applicable for page with Figure presented in portrait orientation (See Appendix T). Page number should be located bottom-centre (right-side portrait) if Figure is presented in landscape orientation (See Appendix S2).
- Illustrations in the form of CD's, slides, and others should be placed in specially made pockets glued to the inner side of the back cover. 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 and understanding. For illustrations other than above, please refer to the following guidelines;

(i) **Photographs**

Photographs should be digitally embedded in the text unless absolutely impossible.

(ii) **Newspaper Cuttings or Similar Materials**

Copies of newspaper cuttings or similar materials should be of high quality.

(iii) **Maps and Aerial Photographs**

Maps and aerial photographs to be included in the thesis should have a written approval by *Ketua Pengarah Ukur dan Pemetaan Malaysia*. Application can be made using PPN 114 (Pind. 1/11) form available at the Perpustakaan UTM.

- It is advisable to scan all illustration materials using a scanner and printing them using a high quality color printer.
3.13.5 **Equations**

The following tips on formatting equations can help you in writing equations:

- All equations are considered as text and numbered according to chapter (see Appendix S). If detailed derivation is needed, it is to be placed in an appendix.
- Mathematical parameters should be written in italics but not units, numbers and mathematical functions like logarithms.
- The equations that are written on a separate line should be centred and done consistently throughout the thesis. Some equations are long and tend to be multi-line equations. If an equation breaks to multiple lines, align them properly and use only one number for the whole equation as far to the right as possible.
- The equation numbers should be enclosed by parentheses and placed at the right-hand side of the page.

3.13.6 **Notes and Footnotes**

Notes such as footnotes and final notes are not allowed for theses in the field of Science and Technology. However, limited use of footnotes is allowed for theses in the field of Humanities and Social Sciences. The use of footnotes should follow the following format:

- Footnotes are recorded using Arabic numeric and numbered consecutively.

- Raised superscript numerals (example²) in the text refer 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.

- Footnotes for references are written differently in the aspect of author's name and the use of punctuation. The author's name should be written in full. Comma or quotation mark should be used to separate author's name, title of the article and publication
details. The font size used should be two (2) points smaller than the text. The style for writing reference as footnotes is shown below:

Numeral Author, "Title of article." publication details, year, page.

Example:

3.13.7 References

References are detailed description of items from which information were 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.

3.13.8 Appendix

Appendices are supplementary materials to the text. These include tables, charts, computer program listings, and others. The following should be noted:

(a) Appendix is not a must in a thesis. If necessary, data used for analysis, example of questionnaires, maps, photographs and other materials which are lengthy to be included in the text or materials that are not required implicitly to clarify matters discussed can be accompanied as appendix.

(b) Appendix can be named as Appendix A, Appendix B, and so on, depends on types and quantity to be included. Specific titles can also be given.

3.13.9 List of Publications

This section lists all published and accepted publications only, authored/co-authored by the candidate related to his/her research. See Appendix V.
CHAPTER 4

REFERENCE STYLE

4.1 Introduction

Referencing, or citing, is an essential component of academic writing, as it acknowledges the sources of information you have used to complete your assignments. Referencing is important because it ensures that you are not open to accusations of plagiarism, identifies your sources and enables readers to locate them, acknowledges copyright and shows respect to the author for their work, demonstrates the validity or credibility of your arguments, demonstrates the extent to which you know the relevant literature, avoid plagiarism and academic misconduct. The details of the references cited in the text should be located in the List of References. The list should be placed at the end of the thesis compiled either alphabetically (Harvard System), numerically Number (Vancouver) System or American Psychological Association (APA). The style selected must be used consistently throughout the thesis. Cross citation are not allowed. The following sections describe the format of referencing for each style.

4.2 Harvard System

Harvard referencing’ is an umbrella term for any referencing style that uses the author name and year of publication. Harvard style is an author-date referencing system. It has two components: the in-text citation and the reference list. In-text references are references written within the main body of text and refer to a quote or paraphrase. They are much shorter than full references. The full reference of in-text citations appears in the reference list. The references cited in the text should be indicated using the name of author and date of publication. There are different varieties of Harvard referencing style. This guide follows the standards described in Style Manual for Authors, Editors and Printers 6th edition.
4.2.1 Citing in the text

The purpose of citing in the text is to provide brief information about the source, sufficient for readers to find full details about the source in the reference list. In-text citations can be presented in two formats:

a. **(Author Date)** – used to show the source of the information you are citing, 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)** – used to emphasise the author by integrating author name into the sentence, followed immediately by date in brackets.

   Example:

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

4.2.2 Citing a direct quote

Author name, publication year and page number(s) must be included when incorporating a direct quotation into a sentence. Use single quotation marks to enclose short quotations. Fit quotations within your sentences, making sure the sentences are grammatically correct.

Example:

When Hudson (2011, p. 1136) suggests that knowledge of tourism and hospitality labour ‘clearly has a contribution to make to current wider societal debates’ she is, as we are, reflecting on the shifting phenomenon of hospitality work.
4.2.3 Citing sources with single author

Using author James Cameron, this takes the form:

(i) As part of sentence: Cameron (2017) states…….

(ii) At the end of a sentence: (Cameron, 2017)

4.2.4 Two or three authors

If there are two or three authors for a cited reference, names should be written as

below for first appearance:

(i) As part of sentence: Mitchell, Thompson and Murphy (2017) states…….

(ii) At the end of a sentence: (Mitchell, Thompson and Murphy, 2017).

And as shown below thereafter:

(i) As part of sentence: Mitchell et al (2017) states…

(ii) At the end of a sentence: (Mitchell et al, 2017).

(d) No author

If possible, use the organisation responsible for the post in place of the author. If not, use the title in italics:

(i) As part of sentence: (A guide to citation, 2017)

(ii) At the end of a sentence: (A guide to citation, 2017, pp. 189-201)
(e) **Multiple Works from the Same Author**

References published in the *same year* by the same author are listed alphabetically according to the title of the work and a lower-case letter (a, b, c, ...) is added immediately after the date, in both the reference list and in-text citations.

(i) As part of sentence: Campbell and Shiller (1988a, b)

(ii) At the end of a sentence: (Campbell and Shiller, 1988a, b)

References published in the *different year* by the same author are listed alphabetically and chronologically.

(iii) As part of sentence: Mitchell (2010; 2017)

(iv) At the end of a sentence: (Mitchell, 2010; 2017)

(f) **Citing Multiple Works in One Parenthesis:**

List the in-text citations in the normal way but with semicolons between different references:


4.2.2 **List of References for Various Types of Publication Materials**

Harvard referencing can vary in style as there is no single resource for this referencing style. All references cited should be listed in the List of References at the end of the last chapter. List the references alphabetically. If more than one published materials by the same author are cited, these materials should be listed chronologically. For example, an article by Scholfield published in 1994 should be listed before the one published in 1997.
### Book

The standard reference format for a book is:

- The title is italicised
- The first letter of the first word is capitalised, after that only proper nouns are capitalised

Author surname(s), initial(s). (Year Published) *Title*. Edition. Place of publication: publisher.

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
</tr>
</thead>
</table>
4.2.2.2 Journal articles

The basic format to cite a journal article is:

Author names (year) ‘Title of article’, Title, volume(issue/season etc), page numbers.

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
</tr>
</thead>
</table>

4.2.2.3 Conference articles

The basic format to cite a conference article is:
Author (Year) Title of the article. Name of the conference. Date of the conference. Place, page.

*Example:*

### 4.2.2.4 Thesis

The basic format to cite a thesis is:

Author (Year) *Title of the thesis*. Thesis award. Place published.

*Example:*

### 4.2.2.5 Legislations

The basic format to cite legislation is:

Name of the country (year) *Title of the legislation*. Legislation number.

*Example:*

### 4.2.2.6 Standards

The basic format to cite a standard is:

Name of the institution (Year). *Standard number*. Place published:
Publisher

*Example:*

### 4.2.2.7 Newspaper article

**Print Format**

a. No Author
   

b. With author
   

**Electronic Format**


### 4.2.2.8 Magazine

The basic format to cite a magazine is:

Author. (Year) Title of article. *Name of magazine*, Volume/Issue no., page

*Example:*


### 4.3 Number (Vancouver) System
In the Number (Vancouver) Style, a number is assigned to each reference as it is used. Even if the author is named in your text, a number must still be used. The original number assigned to the reference is used each time that reference is cited in the text. The first reference you cite will be numbered 1 in the text, and the second reference you cite will be numbered 2, and so on. If you cite reference number 1 again later in the text, you will cite it using the number 1. References are listed in numerical order in a bibliography at the end of your essay.

**4.3.1 Citing in the Text**

All references cited in the text must be assigned numbers using Arabic numeric. The first cited reference should be assigned with number 1. Subsequent cited references should be given consecutive numbers. One of the methods below can be used when citing:

(i) If the name of an author is written as part of a sentence, the reference number should be inserted in parenthesis or square brackets or superscript after the author's name, for example:

"Genetic algorithm was introduced by Holland (1) and was extensively explored by Goldberg (2)."

OR

"Genetic algorithm was introduced by Holland [1] and was extensively explored by Goldberg [2]."

OR

"Genetic algorithm was introduced by Holland\(^1\) and was extensively explored by Goldberg\(^2\)."

(ii) If the name of an author is not part of a sentence, the reference number should be inserted in parenthesis or square brackets or superscript at the appropriate location; for example:

"Recently, evolutionary programming has been applied to various optimization problems (1) and it offers many advantages such as having
global search characteristics."

**OR**

"Recently, evolutionary programming has been applied to various optimization problem [1] and it offers many advantages such as having global search characteristics."

**OR**

"Recently, evolutionary programming has been applied to various optimization problems\(^1\) and it offers many advantages such as having global search characteristics."

### 4.3.2 List of References for Various Types of Publication Materials

In the list of references, the numbers assigned to the source of references cited in the text are listed in incremental order. The styles of writing details on cited publication in the List of References are as follows:

#### 4.3.2.1 Book

Author. *Title of the book*. Edition (if not the first). Place published: Publisher. Year

**Example:**

#### 4.3.2.2 Article in a book


**Example:**
Hussein, S. B., Jamaluddin, H., Mailah, M. and Zalzala, A. M. S. An Evolutionary Neural Network Controller for Intelligent Active Force

### 4.3.2.3 Journal articles

Author. Title of the article. *Title of the Journal*. Year. Volume (number): page.

*Example:*


### 4.3.2.4 Conference articles

Author. Title of the article. *Name of the conference*. Date of the conference. Place published: Publisher. Year. page.

*Example:*


### 4.3.2.5 Thesis

Author. *Title of the thesis*. Thesis award. Name of Institution; Year

*Example:*


### 4.3.2.6 Standards

Name of the Institution. *Title of the standard*. Place published, Standard number. Year

*Example:*


British Standards Institution. *Tongued and Grooved Software Flooring.*
London, BS 1297. 1987

**4.3.2.7 Patent**

Owner's name. *Title of the patent.* Patent number. Year.

*Example:*

**4.3.2.8 Measured drawings**

Name. *Title.* Place published: Note. Year

*Example:*

**4.4 APA Reference**

The APA style is most commonly used to cite sources within the social sciences. The style is now in the 6th edition. Students are advised to check for the latest versions of references styles as the style are frequently updated. The figure below shows the core component of APA reference taken from Mendeley website.
5.1 Introduction

Senate meeting No.01/2002/03 dated 12 Jun 2002 has decided that all graduate students are to submit a copy of Thesis, Dissertation and Master's Project Report in digital form beside the normal bound hardcopy after approval. Students are required to submit three (3) bound hardcopies and three (3) CD containing digital thesis.

The main purpose of implementing digital thesis is to enable theses submitted to UTM be accessible through the Internet. This is in-line with development in digital technology and globalisation. With this implementation, UTM hopes to be projected as a leading university in research and graduate studies.

5.2 Electronic Theses and Dissertations (ETD)

Electronic Theses and Dissertations (ETD) are documents that record results of research or scholarship of graduate students. These documents are prepared in the form...
that can be accessed globally through the Internet. An ETD is the same as the original paper document that has been approved by the panel of examiners and Senate.

5.3 Preparation Process

A thesis that has been examined and approved by Examination Board of Graduate Studies (Senate Sub-Committee) and Senate should be converted into digital form and submitted to the School of Graduate Studies (SPS)/faculty. SPS will then forward both ETD and bound thesis to the Library for archive and access. An ETD must consist of two (2) files, namely pre-access file and full text file.

5.3.1 Pre-access File

Pre-access file is a file that contains information about the author, the panel of examiners and a brief content 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 a reader wishes to access the whole thesis, the reader should contact the librarian for the full text file. The pre-access file includes the first chapter in the bound thesis.

5.3.2 Full Text File

A full text file consists of all contents of the thesis that has been approved by the Senate. This includes all preliminary pages, the main contents of the thesis and all appendices as submitted to the panel of examiners and approved. Writing style as the original bound hardcopy must be retained as presented in Chapters 1 to 4. All these pages must be saved into one (1) file only.

5.4 Preparation Guideline

The following guidelines must be observed:

i. The electronic version must be the same as the final bound thesis as approved by the Senate;

ii. Convert the thesis in PDF format. Use the latest version of Adobe Acrobat PDFMaker. **Do not set the Document Security**;
iii. All pages which contain signatures of the student and supervisor must be scanned;

iv. If the status of a thesis is CONFIDENTIAL or RESTRICTED, electronic version is still required but must be properly indicated in the Thesis Status Declaration form;

v. Two files must be generated. The first file is for the purpose of pre-access that will be made accessible to the public. The second file is the full text file. The files should be named as follows:

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

Where:

a. \<name\> is the student’s first name (without 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 approved

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 texts file

Example 1:
Wan Ahmad Nazri bin Wan Abdullah, is a master’s student at 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
The files should be named as follows:

wanahmadnazrim100123d02thp.pdf (pre-access file)
wanahmadnazrim100123d02tht.pdf (full texts file)

**Example 2:**
Wong Ah Seng, is a UTM staff who studied for his PhD overseas. The thesis is approved in the year 2002 and declared open access. He is a staff of 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> = 31234
<p> = 1
<tt> = 02
<ss> = tt

### Table 5.1 Degree, Faculty and Type of Study’s code

<table>
<thead>
<tr>
<th>DEGREE</th>
<th>FACULTY</th>
<th>TYPE OF STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>P – Doctorate</td>
<td>A – Faculty of Engineering</td>
<td>1 – course work</td>
</tr>
<tr>
<td>M – Master</td>
<td>B – Faculty of Social Sciences and Humanities</td>
<td>2 – course work and research</td>
</tr>
<tr>
<td>U – Undergraduate</td>
<td>C – Faculty of Science</td>
<td>3 – research</td>
</tr>
</tbody>
</table>
The files should be named as follows:

- **wongahsengPB31234l02ttp.pdf**  (pre-access file)
- **wongahsengPB31234l02ttt.pdf**  (full texts file)

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

- **norfaezahPH37171l01sup.pdf**  (Pre-access file)
- **norfaezahPH37171l01sup.pdf**  (Full text file)

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

vii. ETD must be submitted using high quality CD with details of the file printed on a CD cover sticker and placed in a CD casing.

viii. Two (2) CD with three (3) copies of the bound thesis must be submitted to SPS together with the ETD Verification form. Example of ETD Verification form is shown in Appendix V.
Appendix A  Sample of thesis front cover (for viva-voce submission)

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

WAN ZUKI AZMAN WAN MUHAMAD

UNIVERSITI TEKNOLOGI MALAYSIA
Appendix B  Example of thesis declaration form

UNIVERSITI TEKNOLOGI MALAYSIA

DECLARATION OF THESIS / UNDERGRADUATE PROJECT REPORT AND COPYRIGHT

Author's full name :  
Date of Birth :  
Title :  
Academic Session : 2018/2019

I declare that this thesis is classified as:

☐ CONFIDENTIAL  (Contains confidential information under the Official Secret Act 1972)*

☐ RESTRICTED  (Contains restricted information as specified by the organization where research was done)*

☑ OPEN ACCESS  I agree that my thesis to be published as online open access (full text)

1. I acknowledged that Universiti Teknologi Malaysia reserves the right as follows:
2. The thesis is the property of Universiti Teknologi Malaysia
3. The Library of Universiti Teknologi Malaysia has the right to make copies for the purpose of research only.
4. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

SIGNATURE OF STUDENT  
721601-01-8890  
MATRIC NUMBER

SIGNATURE OF SUPERVISOR  
AP. DR. KHAIRUR RIJAL JAMALUDIN  
NAME OF SUPERVISOR

Date: 20 JUNE 2015  
Date: 20 JUNE 2015

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Appendix C  Example of a thesis status declaration letter

Date

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Perpustakaan UTM
UTM, Skudai
Johor

Sir,

CLASSIFICATION OF THESIS AS RESTRICTED
-TITLE AND NAME OF AUTHOR’S-

Please be informed that the above mentioned thesis entitled "TITLE" be classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are

(i)

(ii)

(iii)

Thank you.

Sincerely yours,

NAME, ADDRESS, TELEPHONE NUMBER OF SUPERVISOR

Note: This letter should be written by the supervisor, addressed to Perpustakaan UTM and a copy attached to the thesis.

NOTES: * If the thesis is CONFIDENTAL or RESTRICTED, please attach with the letter from the organization with period and reasons for confidentiality or restriction.
“I/We hereby declare that I/we have read this thesis and in my/our opinion this thesis is sufficient in term of scope and quality for the award of the degree of Doctor of Philosophy (Specialization)”

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 II : MOHD ZULI JAAFAR
Date : 9 MAY 2017
BAHAGIAN A - Pengesahan Kerjasama*

Adalah disahkan bahawa projek penyelidikan tesis ini telah dilaksanakan melalui kerjasama antara ______________________________ dengan __________________________

Disahkan oleh:
Tandatangan : Tarikh :
Nama :
Jawatan :
(Cop rasmi)
* Jika penyediaan tesis atau projek melibatkan kerjasama.

BAHAGIAN B - Untuk Kegunaan Pejabat Sekolah Pengajian Siswazah/Fakulti

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 SPS:
Tandatangan : Tarikh :
Nama :
Appendix E  Example of a title page

ENHANCED PARTICLE SWARM OPTIMIZATION
TITLE
TITLE
TITLE

WAN ZUKI AZMAN WAN MUHAMAD

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (specialisation)

School of Chemical and Energy Engineering
Faculty of Engineering
Universiti Teknologi Malaysia

JUNE 2018
I declare that this thesis entitled “title of the thesis” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 
Name : WAN ZUKI AZMAN WAN MUHAMAD
Date : 10 NOVEMBER 2016
This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time.
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 Shaharoun 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.
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.
Kajian ini dilakukan bertujuan mengkaji penggunaan algoritma genetik (GA) dalam pemodelan sistem dinamik linear dan tak linear dan membangunkan kaedah alternatif bagi pcmilihan struktur model menggunakan GA. Algorithma kuasa dua terkecil ortogon (OLS), satu kaedah penurunan kecerunan digunakan sebagai bandingan bagi kaedah yang dicadangkan. Pcmilihan struktur model menggunakan kaedah algoritma genetik yang diubahsuai (MGA) dicadangkan dalam kajian ini bagi mengurangkan masalah konvergens pramatang dalam algoritma genetik mudah (SGA). Kesu penggunaan gabungan operator MGA yang berbeza ke atas prestasi model yang terbentuk dikaji dan keberkesanan serta kekurangan MGA diu t arakan. Kajian simulasi dilakukan untuk membanding 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 ketcpatan ramalan. Di samping itu, penggunaan carian tempatan dalam MGA untuk menambah baik algorithma tersebut dicadang dan dikaji, dinamai sebagai algoritma mcmetic (MA). Hasil simulasi menunjukkan, dalam kebanyakan kes, MA berkeupayaan menghasilkan model yang bersesuaian dan parsimoni dan mcmenuhi ujian pengsahihan model di samping memperolehi beberapa kelebihan dibanding dengan kaedah OLS, SGA dan MGA. Tambahan pula, kajian kes untuk sistem berbilang pembolehubah menggunakan data eksperimental sebenar daripada dua sistem iaitu sistem pengulang-alk turbo dan reaktor teraduk berterusan menunjukkan algoritma ini boleh digunakan sebagai alternatif untuk mcmerolehi model termudah yang memadai bagi sistem tersebut.
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<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------</td>
<td></td>
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<tr>
<td>ANN</td>
<td>Artificial Neural Network</td>
<td></td>
</tr>
<tr>
<td>UTM</td>
<td>Universiti Teknologi Malaysia</td>
<td></td>
</tr>
<tr>
<td>MTS</td>
<td>Mahalanobis Taguchi System</td>
<td></td>
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<tr>
<td>TM</td>
<td>Taguchi Method</td>
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<td>MD</td>
<td>Mahalanobis Distance</td>
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## LIST OF SYMBOLS

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<tr>
<th>Symbol</th>
<th>Description</th>
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<tr>
<td>$\delta$</td>
<td>Minimal error</td>
</tr>
<tr>
<td>$F$</td>
<td>Force</td>
</tr>
<tr>
<td>$g$</td>
<td>Gravity=9.81 m/s</td>
</tr>
<tr>
<td>$D.g$</td>
<td>Diameter</td>
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CHAPTER 1

INTRODUCTION (Heading 1)

1.1 Problem Background (Heading 2)

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document. To make your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. “For the first paragraph, use ‘Para 2 lines’ style”

For the last paragraph/single paragraph in the section, use ‘Para 4 lines’ style"

1.2 Problem Background

Video provides a powerful way to help you prove your point. When you click Online Video, you can paste in the embed code for the video you want to add. You can also type a keyword to search online for the video that best fits your document. To make your document look professionally produced, Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. Click Insert and then choose the elements you want from the different galleries. Themes and styles also help keep your document coordinated. When you click Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme. “For the last paragraph/single paragraph in the section, use ‘Para 4 lines’ style”

4 line spacing
make your document look professionally produced. Word provides header, footer, cover page, and text box designs that complement each other. For example, you can add a matching cover page, header, and sidebar. Click Insert and then choose the elements you want from the different galleries.

Themes and styles also help keep your document coordinated. When you click Design and choose a new Theme, the pictures, charts, and SmartArt graphics change to match your new theme. When you apply styles, your headings change to match the new theme. Save time in Word with new buttons that show up where you need them.

To change the way a picture fits in your document, click it and a button for layout options appears next to it. When you work on a table, click where you want to add a row or a column, and then click the plus sign.

1.3 Problem Statement

1.4 Research Goal (Heading 3)

1.5 Research Objectives

(a) To formulate the mathematical model …

(b) To design the …

(c) To compare and validate the performance …
After deliberating on doctoral education in Australia in the 1990s, one observer in Australia writes:

The lack of any significant formal course work within our Ph.D. and master degrees by research has continued for three decades. The focus of our Ph.D. research type degrees continues to be the research project, and this is almost the only medium by which education is accomplished.

(Stranks, 1984:171)

Equation (1.1) is a linear equation.

$$y = mx + c$$  \hspace{1cm} (1.1)

Equation (1.1) is a linear equation.

$$MD = D^2 = \frac{1}{k} ZC^{-1}Z^T$$  \hspace{1cm} (1.2)

Mahalanobis distance is calculated using Equation (1.2).
### Table 1.1  Optimality of proposed greedy algorithms

<table>
<thead>
<tr>
<th>Test Case</th>
<th>No. of Tasks</th>
<th>No. of SW Cores</th>
<th>Optimality (%)</th>
<th>Alg-greedy1</th>
<th>Alg-greedy2</th>
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<tr>
<td>MP3</td>
<td>16</td>
<td>2</td>
<td>94.2</td>
<td>77.1</td>
<td></td>
</tr>
<tr>
<td>MP3</td>
<td>16</td>
<td>3</td>
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<td>2</td>
<td>95.0</td>
<td>90.9</td>
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<td>14</td>
<td>2</td>
<td>93.2</td>
<td>90.3</td>
<td></td>
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<td>3</td>
<td>87.3</td>
<td>93.0</td>
<td></td>
</tr>
<tr>
<td>Random3</td>
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<td>3</td>
<td>87.3</td>
<td>94.7</td>
<td></td>
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<tr>
<td>Random4</td>
<td>7</td>
<td>2</td>
<td>85.2</td>
<td>82.1</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2.2  Comparison of experimental and computer simulation results with different distance ratio (Revelle and Harrington, 2017)

<table>
<thead>
<tr>
<th>Distance Ratio</th>
<th>Experiment (mean value)</th>
<th>Computer Simulation (mean value)</th>
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</thead>
<tbody>
<tr>
<td>0.500</td>
<td>0.75</td>
<td>0.861</td>
</tr>
<tr>
<td>0.625</td>
<td>0.83</td>
<td>0.939</td>
</tr>
<tr>
<td>0.750</td>
<td>0.88</td>
<td>0.981</td>
</tr>
<tr>
<td>0.875</td>
<td>0.93</td>
<td>0.997</td>
</tr>
<tr>
<td>1.000</td>
<td>1.00</td>
<td>1.000</td>
</tr>
</tbody>
</table>

### Table 3.3 Description of Datasets

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<th>Data Set</th>
<th>Attributes</th>
<th>Classes</th>
<th>Samples</th>
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<tr>
<td>Breast cancer</td>
<td>9</td>
<td>2</td>
<td>683</td>
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<tr>
<td>Diabetes</td>
<td>8</td>
<td>2</td>
<td>768</td>
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<tr>
<td>Heart</td>
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<tr>
<td>Thyroid</td>
<td>21</td>
<td>3</td>
<td>2069</td>
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</tbody>
</table>

Figure 1.1 Comparison of the average accuracy on the testing set.
Figure 2.2 Critical time-to-area constraint result of MP3 and JPEG streaming

Figure 3.3 Communications among hardware and software tasks in a multi-core architecture (Cheng, 2018)
LIST OF PUBLICATIONS

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Non-Indexed Conference Proceedings
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Appendix V  Sample of an e-thesis declaration/validation form

School of Graduate Studies
Universiti Teknologi Malaysia

VALIDATION OF E-THESIS PREPARATION

Title of the thesis : ______________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Degree: ________________________________________________________________
Faculty: ________________________________________________________________
Year: _________________________________________________________________

I __________________________ (CAPITAL LETTER)

declare and verify that the copy of e-thesis submitted is in accordance to the
Electronic Thesis and Dissertation's Manual, School of Graduate Studies, UTM

__________________________________ (Signature of the student)
Permanent address:
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

__________________________________ (Signature of supervisor as a witness)
Name of Supervisor: ______________________
Faculty: ________________________________

Note: This form must be submitted to SPS together with the CD.