

Ministry of Higher Education & Scientific Research
University of Baghdad – College of Engineering
Mechanical Engineering Department



Methodology of Writing
M.Sc. Theses & Ph.D. Dissertations

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Preface

The present booklet was written to be a simple, clear, and easy to use guide for postgraduate students, to help them in writing their M.Sc. theses and Ph.D. dissertations. The work is based on lecture notes of a course in “*Technical Writing*” given by the author to postgraduate students at the Mechanical Engineering Department / College of Engineering – University of Baghdad. The work also reflects a long experience for the author lasted for more than twenty years of work in the field of postgraduate studies, supervising 38 Thesis and 17 Dissertations, and the membership of the examining committees and evaluation of more than (260) M.Sc. Theses and Ph.D. Dissertations.

The guide was written to be consistent with the prevailing regulations of Baghdad University related to the methodology of writing M.Sc. Theses and Ph.D. Dissertations.

We would like here to express our thanks and appreciation to all who expressed their opinions, notes, and remarks which enrich the work too much.

It should be mentioned here that the work will remain continuous and adjustable for any modifications or development in the future. We will be very grateful to all who will provide us with any opinion, note, comment, or suggestion to improve the work.

God bless all good efforts that serve humanity.....

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Chapter One

General Guidelines

1.1 General

A *Thesis* or *Dissertation* is a document containing information that will advance human knowledge regardless of when that information will be used. Not all theses or dissertations forms are alike. Most colleges publish manuals giving specific directions to fit their individual needs. In general, complete job of writing a thesis or dissertation includes the following phases:

I. Selecting the Subject.

The following are some guiding principles that help in performing this job:

1. The project should require some real research on your part.
2. The research project should be interesting and beneficial to you.
3. The research project should be worthwhile and of real value.
4. The subject should be commensurate with the limitation of time, cost and available data and facilities.
5. Your thesis or dissertation subject should fit local requirements.
6. The thesis or dissertation writer must know where to look for suitable topics.

II. Consulting the Adviser.

1. Don't look upon your thesis advisor as a person who is to do your work.
2. Treat him as an adviser, not as a proof reader.
3. When you need information, ask for it only if it cannot be found elsewhere.
4. Do not expect him to revise your manuscript for you.
5. He shouldn't take the responsibility for a writing job that is yours and yours alone

III. Gathering Material

1. It is the period when facts and ideas, results, and findings, come in from all sides (books, tests, work of other people ...)
2. At the beginning of this phase, look at your problem and try to estimate how big a job it will be.
3. Interviews
4. Questionnaires.
5. Library survey.

IV. Arranging Thesis or Dissertation Material and Writing Up.

The main portion of the thesis or dissertation resembles the body of a long formal report, but with different motivation for writing. The general structure of a M.Sc. Thesis or Ph.D. Dissertation will be described in the next article, in accordance with the instructions and rules of University of Baghdad.

1.2 General Structure of M.Sc. Thesis and Ph.D. Dissertation

In accordance with the instructions and rules of the University of Baghdad, the general structure of M.Sc. Thesis or Ph.D. Dissertation is composed of the following items;

1. Cover Page.
2. Blank white paper after the front cover and another one before the back cover.
3. Title Page.
4. Quran Verse.
5. Supervisor (s) Certificate Page.
6. Examining Committee Certificate and the College Dean Approval.
7. Dedication Page (if there is any).
8. Acknowledgments Page.
9. Abstract.
10. Table of Contents.
11. List of Tables (Optional).
12. List of Figures and Plates (Optional).
13. Nomenclature.
14. Introduction (chapter one).
15. Thesis or Dissertation Chapters; These are usually:
 - a. Survey of Literature (chapter two)
 - b. Mathematical Modeling (chapter three)
 - c. Numerical Solution (chapter four)
 - d. Experimental Apparatus and Procedure (chapter five)
 - e. Results and Discussion (chapter six)
 - f. Conclusions and Recommendations (chapter seven)
16. References.
17. Appendices.
18. Abstract in Other Language.
19. Title Page in Other Language.

Item (15) which includes thesis or dissertation chapters is flexible and may be changes according to the subject of the research and its specialization. Some chapters may be canceled and others may be added. The chapters of mathematical modeling and numerical solution can be merged in one chapter.

1.3 General Important Notes and Remarks

The following are *very important* notes and remarks which should be considered in writing – up the thesis or dissertation.

1. Type of paper: A4 size (297 × 210 mm); White.
2. The writing should be on one side of the paper.
3. Margins
 - a. Binding margin (4cm).
 - b. Other sides (2cm).
4. Use (1.5) line spacing, with size of letter (14), Times new Roman, Black.
5. Each new paragraph should start with a shift of (2cm) to the right (in English) and to the left (in Arabic).
6. Number of pages for M.Sc. thesis should not exceed (125) pages, and (225) pages for (Ph.D.) dissertation.
7. The page numbering and headings:
 - a) In Latin numbering (I, II): from the abstract page to the end of the Nomenclature.
 - b) Numbering (1, 2): from chapter -1- to the end of list of References.
 - c) The Appendices are numbered separately with numbers preceded by the appendix letter.
 - d) The numbers are placed in the middle lower side of the page.
 - e) The headers are placed at the top of the page. It may include the number and title of the chapters and appendices.
8. **Do not** use the word (we or I) in writing anywhere. Instead, use passive voice.
9. It is recommended to place the tables, figures, and plates of each chapter at the end of the chapter, the tables first, the figures second, and then the plates at last.
10. Use the word (figure) without abbreviation (Fig. or fig.).
11. For past events, use the passive voice tens for writing.

12. Do not exaggerate in decoration, colors, frames, writing styles, sketches.....etc.
13. After the examination (discussion of the thesis or dissertation), you have to carry on all the corrections and modifications suggested by the examiners, with their related changes in all sections of the thesis or dissertation.
14. The scientific terms should be translated for its first appearance in the thesis or dissertation (for Arabic thesis or dissertation).
15. The titles of paragraphs, figures, tables...etc., should be written with title form, that is; with capital first letter for all words except the preposition words. The following are examples;

1.2 Applications of the Present Work

Figure (1.1): The Geometry of the Problem

Table (5.1): Properties of the Porous Media used in the Present Work

(Note: Do not place dot (.) at the end of the title, and there should be a space between the colon (:) and the title)

16. The title of the figures should be written *below* the figure, while the title of the tables should be written *above* the table.
17. Do not use **Bold** line in writing, except with the titles of chapters and sections, and in writing references inside the text (not in the list of references).
18. Avoid long titles for chapters, sections, figures, tables, plates.... etc. Use short representative titles.
19. Avoid writing very long paragraphs and sections.
20. Do not use the same title for more than one section or figure or table or plate.
21. All equations and relations should be numbered according to the chapter or appendix where they exist.
22. The equations, figures, tables, and plates are numbered according to the chapter or appendix where they exist, and sequentially according to their mention and use.
23. The photographs are not figures and should be named (Plate) and numbered separately not with the figures, i.e. (Plate (5.1): , Plate (5.2): ... etc.).
24. If there is figure or table or plate includes more than one part and extends for two or more pages, then the title are mentioned in the first page only, and in the next pages the number only is mentioned followed by the word (Contd.) in place of the title.

Chapter Two

Preliminary Pages and Sections

These pages and articles include articles (1 to 13) of the general structure of the thesis or dissertation mentioned in article (1.2) of chapter one.

2.1 Cover Page

1. Color for scientific colleges is red, and for humanity colleges is black.
2. It should be hard cover.
3. The contents of the title page (described later) should be written on the cover with golden letters.
4. The foot of the cover should contain the scientific degree (M.Sc. or Ph.D.), the year and the name, and as follows ;

	M.Sc. Thesis or; Ph.D. Dissertation	(Title Page in Golden Letters)
	Mohammed Ali	
	1997	

2.2 Title Page

It should contain the title of the thesis or dissertation which has been adapted officially in the council of the college, *without* any change or modification, no matter how small this change may be. The following is a sample of M.Sc. Thesis and Ph.D. Dissertation title page;

**Ministry of Higher Education & Scientific Research
University of Baghdad
College of Engineering**



**Experimental and Numerical Investigation of
Natural Convection Heat Transfer from
a Plane Wall to a Thermally Stratified
Environment**

**A Thesis (or Dissertation)
Submitted to the College of Engineering
University of Baghdad in Partial Fulfillment of the
Requirements for the Degree of Master of
Science (or Doctor of Philosophy) in Mechanical Engineering
(Thermo-Fluids)
or (Applied Mechanics)
or (Manufacturing & Industrial Engineering)**

BY

**Naseem Kamil Ali Al Okaili (Name of Student)
(B.Sc. 2002) (for M.Sc. Students)
(B.Sc. 2002, M.Sc. 2006) (for Ph. D. Students)**

**Supervised By
Prof. Dr. Ihsan Y. Hussain**

July 2011

شعبان 1432 هـ

2.3 Supervisor (s) Certificate

The certificate should be done and signed before submitting the thesis or dissertation to the department. The following is a sample for this certificate.

Supervisor (s) Certificate

I (we) certify that this thesis (or **dissertation**) entitled (**Experimental and Numerical Investigation of Natural Convection Heat Transfer from a Plane Wall to a Thermally Stratified Environment**) had been carried out under my (our) supervision at the University of Baghdad / College of Engineering – Mechanical Engineering Department in partial fulfillment of the requirements for the degree of Master of Science (or **Doctor of Philosophy**) in Mechanical Engineering / Thermo-Fluids (or; Applied Mechanics or; Manufacturing & Industrial Engineering).

Signature:

Name: Prof. Dr. Ihsan Y. Hussain

Date: 20 / 7 / 2011

(Note: The date of signature should be before submitting the thesis or dissertation to the department)

2.4 Examining Committee Certificate

Examination Committee Certification

We certify that we had read this thesis (or **dissertation**) entitled (**Experimental and Numerical Investigation of Natural Convection Heat Transfer from a Plane Wall to a Thermally Stratified Environment**) and as an Examination Committee examined the student (**Naseem Kamil Ali Al Okaili**) in its contents and that in our opinion it meets the standard of a thesis (or **dissertation**) and is adequate for the award of the Degree of Master of Science (or **Doctor of Philosophy**) in Mechanical Engineering / Thermo-Fluids (or; Applied Mechanics or; Manufacturing & Industrial Engineering).

Signature:

Name: Prof. Dr. Ihsan Y. Hussain

Date:

(Supervisor)

Signature:

Name:

Date:

(Supervisor)

Signature:

Name:

Date:

(Member)

Signature:

Name:

Date:

(Member)

Signature:

Name:

Date:

(Member)

Signature:

Name:

Date:

(Member)

Signature:

Name:

Date:

(Chairman)

Approved for the University of Baghdad

Signature:

Name:

Date:

Dean of the College of Engineering

2.5 Acknowledgment Page

The acknowledgments page may include thanks and appreciation to:

1. Supervisor (s).
2. Department head.
3. Department staff.
4. Colleagues.
5. Special persons who helped in carrying on the research.
6. Supporting office, ministry, company.... etc.
7. The university in which the student made a research scholarship (if exists).
8. Parents and family.
9. Above all, thanks to God.

2.6 Abstract

The following are a general guide lines for writing the abstract of M.Sc. Thesis or Ph.D. Dissertation:

1. Brief summary of the thesis or dissertation contents.
2. Contains qualitative and quantitative important informations about the thesis.
3. Information includes objective of the work, tools, results and conclusions.
4. It is recommended to write the abstract in the form of paragraphs, and as follows;
 - a. Paragraph describes, in general, the thesis work.
 - b. Paragraph describes the theoretical and numerical parts of the work.
 - c. Paragraph describes the experimental part of the work.
 - d. Paragraph for the results, conclusions and comparisons.
5. The abstract should *not* include the following;
 - a. References.
 - b. Equations or correlations
 - c. Referring to figures or tables.
 - d. Use of undefined abbreviations.
6. The abstract should include numbers and ranges for the important obtained results, improvements, comparisons..... etc.

2.7 Table of Contents

1. It should start from the first page numbered in Latin numbers, which is the abstract page.
2. It should include all heading and subheadings used in the thesis or dissertation.
3. There should be complete resemblance between what is in the table of contents and what has been used inside the text.
4. The Appendices (with their titles) should be listed in this table.
5. There should be a shift (to the right) between the headings of chapters and their sections, and similarly between the sections and sub-sections

Sample

Abstract	I
Table of Contents	III
Nomenclature	X
Chapter One : Introduction	1
1.1 General	4
1.2 Applications	7
1.3 Motivation and Originalities	8
1.3.1 Motivation	9
1.3.2 Originalities	10
1.4 Objectives and Plan of the Present Work	11
Chapter Two : Survey of Literature	12
2.1 Theoretical Works	12
2.2 Experimental Works	18
2.3 Scope of the Present Work	20
Chapter Three : Mathematical Modeling	22
.	
.	
.	
References	120
Appendices	126
Appendix A : Calibration Curves	A-1

2.8 List of Tables and List of Figures and Plates

These tables are optional and may or may not be written. The same titles and numbers used inside the text for the tables, figures, and plates should be used here.

Sample

<u>Table Number</u>	<u>Title</u>	<u>Page Number</u>
(5.1)	Dimensions of the Models	77

<u>Figure or Plate Number</u>	<u>Title</u>	<u>Page Number</u>
(1.1)	Geometry of the Problem	5

2.9 Nomenclature

This article should include symbols and their units. It should include the following sections in sequence:

- I. Latin Symbols (A, b, P, s, S, etc. (English letters)).
- II. Greek Symbols (α , β , γ , δ ... etc.).
- III. Dimensionless Numbers: (Re , Fr , M , Nu , Gr , Pr , Sc , Ri , etc.) , with their definitions.
- IV. Subscripts: ()_i , for example (u_i , T_b , δ_{exp} etc.).
- V. Superscripts: ()^u , for example (u^e , T^p , δ^{th} etc.).
- VI. Abbreviations and acronyms with their meanings, for example (CFD Computational Fluid Dynamic, NASA National Aeronautics and Space Administration, etc.).

I. Latin and Greek Symbols:

1. They should be arranged alphabetically.
2. If there are two symbols with the same letter, but one is with capital letter and the other with small one, start with that with small letter first , for example ;

<u>Symbol</u>	<u>Meaning</u>	<u>Units</u>
t	Time	s
T	Temperature	K

3. If there is a symbol used for two or more meanings, defined them together, and as follows:

<u>Symbol</u>	<u>Meaning</u>	<u>Units</u>
t	Time; also	s
	Dimensionless ratio defined by equation (3.55); also	/
	Dish maximum thickness, see figure (4.1)	m

4. Common mistakes made by students ;
- Unit of time in SI units is (s) not (sec).
 - Some units should be written with capital letters, such as W , J/kg , K , Ampere , Pa ,etc.

II. Greek Symbols

This section includes usually the Greek letters used arranged alphabetically. The following is a list of the Greek letters;

No.	Greek Name	Greek Letter		No.	Greek Name	Greek Letter	
		Lower Case	Capital			Lower Case	Capital
1	Alpha	α	A	13	Nu	ν	N
2	Beta	β	B	14	Xi	ξ	Ξ
3	Gamma	γ	Γ	15	Omicron	\omicron	O
4	Delta	δ	Δ	16	Pi	π	Π
5	Epsilon	ϵ	E	17	Rho	ρ	P
6	Zeta	ζ	Z	18	Sigma	σ	Σ
7	Eta	η	H	19	Tau	τ	T
8	Theta	θ	Θ	20	Upsilon	υ	Y
9	Iota	ι	I	21	Phi	ϕ	Φ
10	Kappa	κ	K	22	Chi	χ	X
11	Lambda	λ	Λ	23	Psi	ψ	Ψ
12	Mu	μ	M	24	Omega	ω	Ω

III. Subscripts & IV. Superscripts

- The common forms used are ;
 - ()_c denotes the center plane values.
 - ()^e denotes the edge values.
- Do not repeat the definition of Latin or Greek symbols with different sub- or superscript that are defined ; for example ; the

following four definitions for the velocity (U) ;

U_c Velocity at the center (m/s)

U_∞ Velocity at free stream (m/s)

U^e Velocity at the edge of boundary layer (m/s)

U_i Velocity at inlet (m/s)

are not needed if the subscripts (c, ∞ , and i) and the superscript (e) are defined in their list. Instead, the velocity (U) only need to be defined, i.e.;

<u>Symbol</u>	<u>Meaning</u>	<u>Units</u>
U	Velocity	m/s

V. Dimensionless Numbers & VI. Abbreviations

1. They should be arranged alphabetically.
2. The dimensionless numbers should be listed with their definitions and forms.
3. Inside the text, they should be defined completely in the first time they are mentioned.

Note:

It is preferable to use tables in writing all the above sections of the nomenclature.

Chapter Three

Introduction

This chapter is an important entrance to the thesis or dissertation and should include the following;

1. It should include a clear picture about the project or problem you are considering, defining it, limiting it, and establishing how important and valuable it seems to you. In doing that, you should concentrate on the physical phenomena and explanations.
2. It should answer the following three questions;
 - a. What is the problem you are considering?
 - b. Why you are interesting in it?
 - c. How you are going to investigate the problem and solving it?
3. You should explain your problem clearly, using figures, sketches...etc.
4. The description of the problem should include the most important engineering applications related to it.
5. The quotation from the references should be referred to clearly. The quoted paragraph or information should be specified and highlighted (between brackets or quotation marks for example).
6. There must be a separate section (Objectives and Plan of the Work), in which the objectives and plan of the research are defined very clearly, using sketches or figures as possible as you can.
7. If the present work is a continuation or extension to another research or line of research adapted by your supervisor (s) or other researchers, you should mention that in the section of (Objectives and Plan of the Work), also you may mention that in the section of (Scope of the Present Work) in the chapter of (Literature Review).
8. In the Ph.D. dissertation, it is very important to add a section titled (Motivation and Originalities), in which the reasons which motivate the research and the claimed originality points are stated clearly.
9. The introduction must not include lengthy details of the work, or results.
10. Do not use or mention too much equations and relations in this chapter.
11. Try to divide the introduction into a number of short sections as possible as you can. Do not use long sections or paragraphs.
12. Relates the introduction to the needs of the reader. You should mention the advantages and disadvantages (drawbacks) of the research and applications.

Chapter Four

Survey of Literature

The chapter may also titled (Literature Review) or (Review of Literature). The following are general guide lines for this chapter;

1. The chapter starts with small paragraph (without number) describing the chapter and its sections, and the period covered by the reviewed literature and the number of the reviewed references.
2. This chapter should include all references and documents having any bearing on your specific problem, especially those in your country (Iraq).
3. The reader should find a comprehensive survey of what has been done by others; what they have written and said, graphic material they have include, and all the statistical detail of past projects.
4. You are responsible on everything you are writing, scientific terminologies, measuring techniques, theories, abbreviations...etc; so you have to know about anything you are writing.
5. The description of the past literature should be critical; that is; you have to discuss and mention the pitfalls and drawbacks and shortages in the literature, not only describing what they did.
6. It is preferable to divide the chapter into a number of sub-sections; for example:
 - a. Theoretical Researches (for theoretical works only).
 - b. Experimental Researches (for experimental works only).
 - c. Theoretical and Experimental Researches (for theoretical and experimental works).
7. In each section, the review of the literature must be arranged historically; the oldest research mentioned first, the one after is the second etc.
8. The chapter should ends with a section titled (Scope of the Present Work), in which, the position of the present work (thesis or dissertation) with respect to the past reviewed literature, is explained, and the difference between them is clarified , the shortages and gaps which will be covered by the present work should be declared, especially the originality points (for Ph.D. Dissertation). If the

present work is a continuation or extension to another research or line of research adapted by your supervisor (s) or other researchers, you should mention that in this section

9. Referring to the References; There are two methods commonly used in referring to references, these are;
 - a. Numbering the references; the first reference referred to in the thesis or dissertation is given number (1) (**Ahmed (1)** studied), the second one takes number (2)..... etc. The references in the list of references at the end of the thesis or dissertation are arranged sequentially according to their numbers (1), (2), (3) ...etc.
 - b. Refer to the reference by the author (s) sir name (s) and the year inside the thesis or dissertation (**Ahmed and Ali 1990**) without number, and in the list of the references, they are arranged alphabetically according to the author (s) name (s).

The second method is preferable since you can insert any other reference without altering their sequence, as it is required in the first method (numbering). The chosen method of referring to the references should be followed in all parts of the thesis or dissertation, and it is not allowed to use the first method in some parts and the second one in other parts.

10. Inside the text of the thesis or dissertation, the sir name of the author (s) only should be mentioned (**John and Yousif 1990**), while in the list of the references, the full names are mentioned (John A.Muller and Yousif J.Ahmed , “ Numerical study”).
11. If the reference has three or more authors, then inside the text mention should be made for the name of the first author only followed by the word (et.al), i.e. (**John et.al 1995**), while in the list of references, the names of all authors should be mentioned.
12. It is preferable to summarize the reviewed literature in a table includes the information about all the references (author (s) name (s), year, geometry, type of study (theoretical or experimental or both), boundary conditions, range of investigated parameters, correlations, important results..... etc.). The references in the table are arranged

according to their historical sequence, the oldest one first and the updated reference last. The present work (thesis or dissertation) should also be included in the table as the last reference (last cell of the table). Sample for this table is shown in the appendix.

13. There must be a lot of new and modern reviewed references in this chapter.
14. If books are used as references, then the titles of these books in the list of references should be underlined.
15. The review of literature should be written in past tense in general.
16. If a past reference proposed a New model or New method at the time of that reference; then when this is mentioned in the chapter, the time or period of this New thing should be mentioned.
17. All references listed and mentioned in the list of references should be either reviewed in this chapter or used in other parts of the thesis or dissertation. Any reference (s) that are not used or reviewed should not be listed.
18. If you use or review a reference (ref. A for example) that is not available to you but it is cited in other available reference (ref. B for example); then when you mention the reference A in the list of references, write (cited in reference B).

Chapter Five

Mathematical Modeling

This chapter includes the theoretical background of the problem of the research (governing equations, assumptions, correlations, initial and boundary conditions... etc.). The following are general guidelines for the chapter;

1. The chapter starts with small paragraph (without number) describing its contents and sections.
2. The chapter is usually written with the following sections, which represent the steps of the mathematical modeling;
 - 1) Geometry and coordinate system.
 - 2) Assumptions; and their physical justifications.
 - 3) Governing Equations; in their final form after using 2-above.
 - 4) Initial and Boundary Conditions.
 - 5) Further Calculations (based on the solution of the governing equations).
 - 6) Method of Solution.
3. There should be a clear figures or sketches for the problem under consideration.
4. If there are very long derivations of some equations, you may place them in Appendix.
5. All symbols used in the chapter should be clearly defined in the Nomenclature, and also in the text for their first appearance.
6. All the chapter parts or sections should be devoted to and concentrated on your own problem. They shouldn't be general in any way.
7. You should refer to any reference used in writing the sections of the chapter, especially the equations, correlations, or any other values or figures for the parameters of the problem.

Chapter Six

Numerical Solution

This chapter includes the numerical solution of the mathematical model derived in the previous chapter. This solution may include the build-up or development of a computer program done by the student, or using existing software package in solving the problem. The following are general guidelines for the chapter;

1. The chapter starts with small paragraph (without number) describing its contents and sections.
2. The chapter is usually written with the following, sections;
 - 1) Grid Generation; in the calculation domain.
 - 2) Numerical formulation; of the governing equations derived in the Mathematical Modeling.
 - 3) Incorporation of Initial and Boundary Conditions.
 - 4) Numerical Further Calculations.
 - 5) Numerical Calculations Algorithm.
 - 6) Computer Program; Input, output data, specification, flow chart, run time...
3. The chapter shouldn't be in any way, a general one. It should be specifically designed to fit the demands of your own problem.
4. If a software package is used to solve the problem, such as Fluent, COMSOL, NASTRAN, etc., then the chapter shouldn't contain a detailed description of the package and its use, these details may be placed in a separate Appendix.

Chapter Seven

Experimental Apparatus and Procedures

This chapter includes a detailed description of the experimental test rig and instrumentation, and the experimental procedure followed during the test runs. The following are general guidelines for the chapter;

1. The chapter starts with small paragraph (without number) describing its contents and sections.
2. The chapter is usually written with the following sections;
 - a. Experimental Facilities: (Models, Test Section Structure, Fans, Blowers, Tunnels, Tanks etc.).
 - b. Instrumentation: (used for measurements, strain gages, pressure probes, thermocouples, LDA etc.).
 - c. Calibration Curves (for measuring instruments. testing devices, etc.).
 - d. Experimental Procedure (steps of carrying out the experiments).
 - e. Method of Calculations (which includes sample of calculations of the experimental data and their processing).
 - f. Error Analysis.
 - g. Repeatability Check (which ensures that the test rig give the same readings (within acceptable accuracy) for the same run when repeated two or three times with the same input data and conditions, at different times and dates).
3. The place at which the experiments were made should be mentioned (for example; Fluid Mechanics Lab. at the Mechanical Engineering Department / College of Engineering – University of Baghdad)
4. The chapter should be provided with accurate engineering drawings and sketches, and photos for the various parts of the test rig.
5. The role and contribution of the student in building the test rig and instrumentation should be stated clearly and honestly, especially if the test rig is not new but modified from a previous one.
6. It is very important to carry on a “Dimensional Analysis & Similitude” when designing and constructing the model (s) and experimental apparatus, and also when analyzing the experimental results and the relation between model(s) and prototype(s).
7. There should be a section for the design considerations of the test apparatus.
8. The range(s) of measured variables should be stated clearly.

Chapter Eight

Results and Discussion

This is the most important chapter of the thesis or dissertation, because it represents the outcomes of the research through which one can evaluate and judge the quality of the work. The following are general guidelines for the chapter;

1. The chapter starts with short paragraph (without number) describing its content and sections.
2. The chapter is usually arranged as follows:
 - a. Experimental Results.
 - b. Theoretical (or Numerical) Results.
 - c. Comparison and Verification.
3. Advisers say that “the weakest part of many thesis and dissertations is the discussion of results”.
4. Make the discussion as strong and valuable as possible by being objective.
5. Discussions, opinions and judgments must be based on the results of experimentation and research and not on any wishful thinking.
6. Show what your findings mean to the entire area of the knowledge.
7. Discuss the results, if possible, in terms of the literature you surveyed.
8. Evaluate the project (research) as a whole.
9. Don't be afraid to discuss any poor features you feel the results have, any disappointments you encountered.
10. State what you think may result from your finding.
11. If you think that any practical applications may evolve, discuss them and suggest methods for extending your work.
12. Point out any qualifications or limitations the results have.
13. Brings to light suspected sources of error.
14. Recognize unexpected results and try to account for them.
15. Evaluate the results and investigate their significance.
16. The titles of the figures and tables should distinguish between theoretical, numerical, and experimental results.
17. All investigated cases mentioned in the theoretical, numerical, and experimental works of the thesis or dissertation should be presented and discussed in this chapter, and no any case should be excluded; otherwise, it should be omitted and cancelled from the investigated cases mentioned in previous chapters.

Chapter Nine

Conclusions and Recommendations

This chapter is very important for the reader of the thesis or dissertation, because it summarizes all the results and outcomes of the research and suggests further futuristic lines of research stem from the problem of the thesis or dissertation. The following are general guidelines for the chapter;

1. The chapter starts with short paragraph (without number) describing the problem under research in the thesis or dissertation.
2. The chapter is usually written in the following form;
 - 1) Conclusions
 - 1.1 Conclusions from the Theoretical Work.
 - 1.2 Conclusions from the Experimental Work.
 - 2) Recommendations (or Suggestions for Future Work).
3. Conclusions usually stem from the discussion of results.
4. Each figure (or set of figures) in the results which investigate a certain effect or parameter on the problem, should have a separate conclusion in this chapter.
5. The known and pre-developed fundamental facts and principles shouldn't be written as conclusions.
6. The conclusions should be written in compact, short, and clear sentences. Avoid long and boring sentences and paragraphs.
7. Recommendations for further future works should be logical and can be made within the available facilities.

Chapter Ten

References

This article usually involves large errors made by the students. The write-up of the list of references needs large care and patience from the student. The following are general guidelines for writing this article;

1. If the numbering, method is used, the references are arranged according to their numbers ((1), (2), (3)).
2. If the other method is used (Author, year), then the references are arranged alphabetically according to the author's name.
3. There should be line spacing between each reference and the other.
4. See the list of references sample in the appendix for complete details about the writing method of references.

Chapter Eleven

Appendices

This section is an integral and important part of the thesis or dissertation. The following are general guidelines for writing this section;

1. The appendices are highly useful and important parts of the thesis or dissertation, even though they are showed into the background behind the body of the thesis or dissertation.
2. They are the place to put any material that needs to be included in the thesis or dissertation but that is not an essential, it is integral part of the main presentation.
3. The justification for the use of appendices is “Important ideas should not be buried under a mass of details”. The appendix makes it possible to unload detailed information or information of secondary importance from the main presentation, yet still to include it for record purposes.
4. Every section of the appendix should be keyed to the text by a specific reference. Any material that is not connected to the text is not worth putting into the thesis or dissertation at all.
5. The appendices should be arranged according to the order in which they are referred to in the text, and they should be lettered serially (Appendix A, Appendix B, etc.).
6. Each appendix is numbered separately with numbers preceded by the appendix letter (A-1, A-2 ...).
7. The figures, tables, charts and equations in each appendix are numbered separately by numbers preceded by the letter of the appendix (Figure (A.1), equation (A.5), Table (A.3)).
8. You can use and refer to the same references used in the thesis or dissertation, if you need to.
9. The appendices may contain the following material;
 - a. Tables, graphs, or illustrations that are integral part of the main problem but which will not conveniently fit in the text.
 - b. Tables, graphs, or illustrations that are not used in the main problem by they form the basis for it or they are related to it.
 - c. Tabulations of data (experimental, theoretical, numerical).
 - d. Detailed description of equipment or procedure.

- e. Derivations of equations.
 - f. Samples of calculations.
 - g. Samples of forms, data sheets, or questionnaires used in the investigation.
 - h. Publications from the thesis or dissertation (papers, reports).
 - i. Standard terminologies used in the thesis (Wing terminology, Airfoil terminology ... etc.).
10. Each Appendix should have a separate Title.

Chapter Twelve

Abstract and Title Page in other Language

The other language is the Arabic (or English for theses and dissertations written in Arabic language).

1. The abstract should be preceded by the title of the thesis or dissertation in the same other language (Arabic).
2. There must be a complete similarity between the two abstracts and title page.
3. The general form for the abstract is;



وزارة التعليم العالي والبحث العلمي
جامعة بغداد - كلية الهندسة
قسم الهندسة الميكانيكية

الحمل المختلط و الحر في حيز محدد من وسط مسامي مع شروط حدية منتظمة و دورية

رسالة (او اطروحة) مقدمة الى كلية الهندسة - جامعة بغداد كجزء من متطلبات نيل درجة
ماجستير علوم (او دكتوراه فلسفة) في الهندسة الميكانيكية
(موائع و حراريات) او (ميكانيك تطبيقي) او (تصنيع و صناعية)

من قبل

(اسم الطالب)

لمى فاضل علي

(طلبة الماجستير)

بكالوريوس 1995

(طلبة الدكتوراه)

بكالوريوس 1995 ، ماجستير 1999

باشراف

أ.د. احسان يحيى حسين

ذو القعدة 1434

أيلول 2013

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الخلاصة

يقدم البحث الحالي دراسة نظرية وعملية لأننتقال الحرارة بالحمل المختلط العابر في حيز محدد مائل ذو وسط مسامي محصور و مشبع بالمائع و مسخن بفيوض حراري ثابت و دوري ذو دالة جيبيية.

في الدراسة النظرية تم إستخدام طريقة الحجم المحكوم و الضمني و التي تعتبر طريقة خاصة لصيغة الفروق المحددة لتحليل مسألة البحث الحالي. ان التحقق العددي قد غطى كل قيم الفيوض الحراري الثابت المسلط تحت الدراسة للمدى ($250 \leq q_w \leq 37500$ واط/م²) , اي ضمن مدى لرقم رالي (995 الى 87120) وفي كلا حالي الحمل الحر (ملم $\Delta h = 0$) و الحمل المختلط and ملم $\Delta h = 20$, ملم $\Delta h = 15$, ملم $\Delta h = 10$, ملم $\Delta h = 5$) (ملم $\Delta h = 30$ اي ضمن مدى لرقم ريتشاردسون (0.46 الى 74.2). التردد الجيبيي ذو المدى ($250 \leq q_w \leq 1250$ واط/م²) و قيم الفترة الزمنية (30 – 120) ثانية قد تم دراسة تأثيرها. كما تم التحقق من تأثير تغيير زوايا الميل ($0^\circ - 45^\circ$) و زوايا الدوران ($15^\circ - 45^\circ$) ايضا. بالإضافة لذلك تم تجهيز الفيوض الحراري بإستخدام مسيطرين من تناسب و تناسب تكاملي للوصول الى درجة حرارة مطلوبة لقاعدة الحيز ذات قيمة 90 درجة سيليزية.

خلال العمل التجريبي من البحث تم بناء جهاز عملي يتكون من مكعب من النحاس طول ضلعه 0.2 متر و مسلط على قاعدته فيوض حراري ثابت و فيوض حراري دوري ذو موجة جيبيية متغيرة المدى و الفترة الزمنية. تم إختيار الماء المقطر كمائع تشبّع بينما أستخدمت كريات زجاجية من مادة الصودا المطلية بالكلس كمادة مسامية و بقطر يتراوح باربعة اقطار مختلفة (2.4 – 2.7 ملم). للفيوض الحراري الدوري تم دراسة تغير مدى الموجة الجيبيية (≤ 3465 م/واط و $a \leq 5775$) و الفترة الزمنية ذو القيم (1800 – 600 ثانية). تم دراسة وتحليل انتقال الحرارة في حالة الحمل الحر الخالص (ملم $\Delta h = 0$) و في حالة الحمل المختلط , ملم $\Delta h = 10$)

(ملم $\Delta h = 30$, ملم $\Delta h = 20$ اي ضمن مدى لرقم ريتشاردسون (0.872 الى 22.37). تم إجراء سلسلة من التجارب العملية مع تسليط فيض حراري ثابت خلال كل تجربة تراوح مداه من 1650 واط/م² الى 5775 واط/م², اي ضمن مدى لرقم رالي (3106 الى 13883) ولثلاثة زوايا ميلان (0° , 15° , و 30°). لقد تم ربط وحدة سيطرة بجهاز تحصيل البيانات و إستخدامهما لتجهيز فيض حراري مسيطر خاضع لقانوني السيطرة التناسبي و التناسبي التكاملي.

لقد أظهرت النتائج النظرية و العملية ان معدل قيم نسلت تنخفض بزيادة ارتفاع الضغط و تزداد بزيادة الفيض الحراري الثابت في حالة التسخين الثابت و تنخفض بشكل دوري بزيادة الزمن و مدى الدالة الجيبية في حالة التسخين الدوري. ان المعدل الزمني لقيم نسلت تنخفض بزيادة الفترة الزمنية للدورة للدالة الجيبية. كما ان النتائج العملية اظهرت ان المسيطر التناسبي التكاملي افضل من المسيطر التناسبي نظرا لقبايته على اخمد تأثير الاضطراب الحراري الخارجي.

إنّ تحقّق برنامج الحاسوب للدراسة الحالية لحالة معينة لانتقال الحرارة بالحمل في الوسط المسامي اظهر اكبر نسبة خطأ 9% عن الدراسات السابقة. كذلك تمت مقارنة النتائج النظرية بالنتائج التجريبية للبحث الحالي للحالتي الحمل المختلط و الحر مع تسليط فيض حراري منتظم و دوري ذو موجة جيبية على السطح السفلي للحيز و اظهرت هذه المقارنة 2.76% كأصغر نسبة خطأ و 55% كأكبر نسبة خطأ.

Appendix

Samples for Some Parts of the Thesis or Dissertation

Nomenclature

Latin Symbols

Symbol	Description	Units
a	Dimensional amplitude	W/m ²
A	Area	m ²
c	Specific heat	kJ/kg. °C
C _p	Specific heat at constant pressure	kJ/kg. °C
d _p	Particle diameter	m
g	Gravitational acceleration	m/s ²
\vec{g}	Body acceleration vector	m/s ²
h	Heat transfer coefficient	W/m ² . °C
p	Pressure	N/m ²
\vec{P}	Pressure vector	N/m ²
p _C	Hydrostatic pressure head value	N/m ²
P _o	Electric power	W
q	Heat flux	W/m ²
t	Time	s
T	Temperature	°C
T ₁	Top wall average temperature	°C
T _o	Reference temperature	°C
T _x , T _y , T _z	Temperatures at control volume faces in x, y, z directions respectively	°C
u	Velocity component in x-direction.	m/s

v	Velocity component in y-direction.	m/s
V	Volume	m^3
\vec{V}	Volume-averaged velocity vector	m/s
V_h	Voltage across the heater	volt
V_{out}	Outlet fluid velocity	m/s
w	Velocity component in z-direction.	m/s
x	Dimensional length of the x-axis.	m
y	Dimensional length of the y-axis.	m
z	Dimensional length of the z-axis.	m

Greek Symbols

Symbol	Description	Units
α	Angle of inclination from the y axis	degree
α_m	Thermal diffusivity of the porous medium	m^2/s
β	Thermal volume expansion coefficient	1/K
ε	Porosity (fraction of the total media volume occupied by void space)	-
ν	Kinematic viscosity	m^2/s
ρ	Density	kg/m^3
σ	Specific heat ratio, $\sigma = \frac{(\rho C)_m}{(\rho C_p)_f}$	-
∇	Del operator	-
Δt	Time increment	s
$\Delta x, \Delta y,$ Δz	Distance between the grid points in x, y, z directions respectively	m
τ	Period	s

Dimensionless Numbers

Symbol	Description	Units
Da	Darcy's number $Da = K/L^2$	-
Gr	Grashof number, $Gr = \frac{Ra}{Pr}$	-
Nu	Nusselt number, $Nu = \frac{hL}{k_{eff}}$	-
Ra	Rayleigh Number, $Ra = \frac{g\beta KqL^2}{k_{eff}v_f\alpha_m}$	-
Re	Reynolds Number, $Re = \frac{V_{out}d_p}{v_f}$	-
Ri	Richardson Number, $Ri = \frac{Ra}{Pr Re^2}$	-

Subscripts

Symbol	Description
eff	Effective
f	Fluid
g	face of the boundary nodal point
G	Boundary nodal point
s	Solid
w	Wall
x, y, z	Component in the x, y, z-direction

Superscripts

Symbol	Description
<i>o</i>	Fluid property at time <i>t</i>

Abbreviation

Symbol	Description
QUICK	Quadratic Upstream Interpolation for Convective Kinetics
TDMA	Tri-Diagonal Matrix Algorithm

References

Note: The following list is written according to the second method (Alphabetic order)

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Table (2.1): Summary of the Literature Review

Authors	Year	Type of study	Geometry	Type Porous media	Thermal B.Cs.	Range of parameters	Correlations
Hickox and Gertling	1985	Numerical	Annular cylinder	Saturated porous media	Adiabatic horizontal boundaries and constant temp. vertical boundaries.	Ra = 25-100 Radius ratio=2-8	
Kaviany	1986	=	Concentric cylinders	=	Isothermal horizontal cylinders.	Ra=3×10 ³ and 10 ⁵ H/R _i =2-8	
Hsiao et.al	1992	=.	Horizontal cylinder	packed spheres	Uniform wall temperature and uniform heat flux.	Ra _m =15-273 Ra _i =1.0 ³ ×10 ⁵ - 1.67×10 ⁷ .	
Murty et.al.	1994	=	Vertical cylinder enclosure .	Saturated porous media	maintained at constant difference temperature (T _{cylinder} >T _{porous})	Ra=0.04-200 h/d=3 Da=1	
Taofik et.al	1999	=	vertical cylindrical	Saturated porous media	periodic lateral heat flux density	Ra* =2.10 ³ Bi=2.10 ³	
Saaed	2000	=	horizontal cylinder	=	constant hot temperature	Ra =50-500	Nu=0.07545Ra ^{0.5} D ^{-0.59} Nu=0.07225Ra ^{0.55} D ^{-0.55}
Takhar et.al	2001	=	vertical thin cylinder	=	isothermal cylinder.	Pr (0.7 ,5.4 ,7.0) .	
Khalid AbdAl-husseini	2002	=	concentric vertical cylinders.	=	Insulated top and bottom surface and constant difference temperature at other surfaces (T _i >T _o).	100≤Ra*≤100 0 Radius ratio(2≤γ≤1)	Nu _i =0.477477A ^{0.383300} *Ra ^{0.508345} * γ ^{-0.399200} *τ ^{-0.057160}

AL-Najar	2004	=	two separated horizontal cylinders.	=	The cylinders kept isothermal--ly hot while the bounded cavity is isothermal--ly cold	$0 \leq Ra \leq 800$	$Nu_{c1} = 1 + 0.00582 * Ra^{*1.2098} * X^{*0.1389} * D^{*-0.014} * T^{*0.0419}$ $Nu_{c2} = 1 + 0.0027 * Ra^{*1.310} * X^{*-0.0355} * D^{*-1.080} * T^{*1.2843}$
Saada et.al .	2007	=	horizontal circular cylinder.	Fibrous layer	The cylinders kept isothermally , and placed in air ($T_{\infty} > T_w$)	$Da \leq 10^{-7}$ $Ra = 10^8$ $Pr = 0.7$	
Prasad et.al.	1986	Experiment--al	vertical porous annulus	3-and-6mm-dia-glass beads and 6.35 mm dia.	constant heat flux on inner wall and outer surface isothermally cooled	$0.2 < Pr^{*} < 100$ $50 < Ra^{*} < 1000$	$a^{*} = \rho g c \beta k q D^2 / \nu K m^2$ $Nu = q D / (T_{m,i} - T_o) K m$
Ozgun and Teka.	2010	=	horizontal cylinder	layer of textile material	Constant heat flux	Diameter were increased to 9 mm for 4.8 mm and 12.8 mm for 9.4 mm after coating . varied between 10 C°-40 C° and 20 C°- 60 C° $Ra \leq 10^{12}$	
Present work	2013	Numerical and Experimental	inclined cylindrical enclosure	Glass bead	insulated upper and lower ends and two case for other surface : constant heat flux , the second periodic heat flux.	Period(10,22,5 0,90min), amplitude(500 ,1000,1500.20 00w/m ²), inclination angle(0 ⁰ ,25 ⁰ , 50 ⁰ ,70 ⁰ ,90 ⁰)	For $\alpha = 0^{\circ}$: $Nu = (0.0381565)^*(x)^*$ $*(1.372186$ For other α : $Nu = (289.095)_{+}(65.67$ $21)^*(Ra \sin(\alpha))$