

## **ACKNOWLEDGEMENTS**

First and foremost, I would like to thank God.

Secondly, I would like to express my utmost gratitude to my thesis supervisor, Dr. Fatah al Rahman, who gives me support, guidance, continuous encouragement throughout my project thesis. Without help from him, I would not be unable to complete this report.

Finally, I would like to give a special thanks to my parents and my friends for their care, love and support during my study.

## المستخلص

في هذه الدراسة تم عمل المعادلات الاساسية باستخدام طريقة العنصر المحدد للجملونات الفراغية وقد استخدمت هذه المعادلات لعمل برنامج في الماتلاب, وقد سمي هذا البرنامج بتحليل الجملونات الفراغية باستخدام برنامج الماتلاب. تم تحليل بعض الجملونات البسيطة باستخدام هذا البرنامج للتأكد من فعالية البرنامج, وايضا تم تحليل نفس الجملونات بواسطة برنامج الساب 2000 وقد وجدت النتائج متطابقة.

## **ABSTRACT**

In this study the Finite Element formulation for space trusses was modeled in MATLAB Program Language. The modeled Program named **A**nalysis of **S**pace **T**russ by using **M**ATLAB **P**rogram language (**ASTMP**). Numerical examples were used in order to check the (**ASTMP**) program. The results obtained by **ASTMP** were also verified by using structural analysis software program SAP2000 and were found to be acceptable.

# TABLE OF CONTENTS

<b>TITLE</b>	<b>PAGE</b>
<b>ACKNOWLEDGEMENTS</b>	<b>i</b>
<b>ABSTRACT</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>iv</b>
<b>LIST OF TABLES</b>	<b>vi</b>
<b>LIST OF FIGURES</b>	<b>viii</b>
<b>LIST OF SYMBOLS</b>	<b>x</b>
<b>CHAPTER ONE : GENERAL INTRODUCTION</b>	<b>1</b>
1.1 Introduction to Finite Element Method	<b>1</b>
1.2 Introduction to Space Truss	<b>4</b>
1.3 Objective of Research	<b>5</b>
1.4 Methodology of Research	<b>5</b>
1.5 Outlines of Research	<b>5</b>
<b>CHAPTER TWO: LITERATURE REVIEW</b>	<b>7</b>
2.1. Historical Background of Finite Element	<b>7</b>
2.1.1 The Basic Principles Of The Finite Element Method	<b>13</b>
2.2 Trusses	<b>17</b>

2.2.1	Space Truss	<b>21</b>
	<b>CHAPTER THREE: FINITE ELEMENT FORMULATION FOR SPACETRUS</b>	<b>27</b>
3.1	Formulation for Space Truss	<b>27</b>
	<b>CHAPTER FOUR: IMPLEMENTATION OF FORMULATION IN MATLAB PROGRAMMING LANGUAGE</b>	<b>38</b>
4.1	Introduction about MATLAB program	<b>38</b>
4.2	Applications of M ATLAB Program	<b>38</b>
4.3	Advantages using MATLAB program	<b>40</b>
4.4	space truss program (3D)(ASTMP)	<b>44</b>
4.5	Steps of Running (ASTMP) program	<b>44</b>
	<b>CHAPTER FIVE: ANALYSIS OF SPACE TRUSSES AND RESULT</b>	<b>48</b>
5.1	Introduction	<b>48</b>
5.2	Three Members Space Truss	<b>48</b>
5.3	Four Members Space Truss	<b>54</b>
5.4	Twenty Five-Bar Space Truss	<b>59</b>
5.5	Prismatic Shaped Space Truss	<b>66</b>
	<b>CHAPTER SIX: CONCLUSION AND RECOMMENDATION</b>	<b>73</b>
6.1	Conclusions	<b>73</b>
6.2	Recommendations	<b>73</b>
	<b>REFERENCES</b>	<b>74</b>

**APPENDIX A**

**77**

**APPENDIX B**

**82**

## **LIST OF TABLES**

<b>PAGE</b>	<b>TITLE</b>	<b>TABLE NO.</b>
12	Time Line of Important Developments.	Table 2.1
50	Displacement at node 4 in X-direction for three members Truss.	Table 5.1
50	Displacement at node 4 in Y-direction for three members Truss.	Table 5.2
50	Internal force in members due to applied pint load 5000lb for three members Truss.	Table 5.3
51	Internal forces due to applied different point loads in member 3 for three members Truss.	Table 5.4
55	Displacement at node 1 in X-direction for Four Members Truss.	Table 5.5
55	Displacement at node 1 in Y-direction for Four Members Truss.	Table 5.6
55	Displacement at node 1 in Z-direction for Four Members Truss.	Table 5.7
56	Internal forces in members due to applied point load 10000N for Four Member Truss.	Table 5.8

56	Internal forces due to applied different point loads in member 3 for Four Member Truss.	Table 5.9
60	Nodal loads for the 25-bar truss.	Table 5.10
60	Nodal Coordinates.	Table 5.11
61	Displacement at node 2 in X-direction for Twenty Five-Bar Space Truss.	Table 5.12
61	Displacement at node 2 in Y-direction for Twenty Five-Bar Space Truss.	Table 5.13
61	Displacement at node 2 in Z-direction for Twenty Five-Bar Space Truss.	Table 5.14
62	Internal Force in Members due to applied point loads for Twenty Five-Bar Space Truss.	Table 5.15
63	Internal forces due to applied different point loads in member 25 for Twenty Five-Bar Space Truss.	Table 5.16
68	Displacement at node 8 in X – direction for Prismatic Shaped Space Truss.	Table 5.17
68	Displacement at node 8 in Y-direction for Prismatic Shaped Space Truss.	Table 5.18
69	internal force in members due to applied point load 5000N for Prismatic Shaped Space Truss.	Table 5.19
70	Internal force due to applied different point loads in member 4 for Prismatic Shaped Space Truss.	Table 5.20

## **LIST OF FIGURES**

<b>PAGE</b>	<b>TITLE</b>	<b>Figure NO.</b>
3	(a) Finite difference and (b) finite element discretizations of a turbine blade profile.	Fig.1.1
11	Example of (a) a truss and (b) a similarly shaped plate supporting the same load.	Fig.2.1
20	Space trusses. (a) Side view and top view of a truncated Truss dome. (b) A space truss constructed from plane trusses.	Fig.2.2
26	Examples of single layer dome.	Fig.2.3
27	The element geometry of space (3D) bar element	Fig.3.1



28	Displacements and forces of the 3D bar element	Fig.3.2
31	global and local coordinate system.	Fig.3.3
42	Flow chart of Analysis Space Truss using MATLAB program ( <b>ASTMP</b> ).	Fig.4.1
45	Input data for three members Truss.	Fig.4.2
46	Boundary conditions and loads data for three members Truss.	Fig.4.3
47	Results of displacements and internal forces for three members Truss.	Fig.4.4
49	Three members Truss.	Fig.5.1
52	Displacement at node 4 in X-direction for three members Truss.	Fig.5.2
52	Displacement at node 4 in Y-direction for three members Truss.	Fig.5.3
53	Internal force due to applied different point loads in member 3 for three members Truss.	Fig.5.4
54	Four Member Truss.	Fig.5.5
57	Displacement at node 1 in X-direction for Four Member Truss .	Fig.5.6
57	Displacement at node 1 in Y-direction for Four Member Truss.	Fig.5.7
58	Displacement at node 1 in Z-direction for Four Member Truss.	Fig.5.8
58	Internal forces due to applied different point loads in member 3 for Four Member Truss.	Fig.5.9

59	Twenty Five-Bar Space Truss	Fig.5.10
64	Displacements at node 2 in X-direction Twenty for Five-Bar Space Truss.	Fig.5.11
64	Displacements at node 2 in Y-direction for Twenty Five-Bar Space Truss.	Fig.5.12
65	Displacements at node 2 in Z-direction for Twenty Five-Bar Space Truss.	Fig.5.13
65	Internal force for different point loads in member 25 for Twenty Five-Bar Space Truss.	Fig.5.14
67	Prismatic Shaped Space Truss (Geometry and Data).	Fig.5.15
71	Displacement at node 8 in X -direction for Prismatic Shaped Space Truss.	Fig.5.16
71	Displacement at node 8 in Y-direction for Prismatic Shaped Space Truss.	Fig.5.17
72	Internal force due to applied different point loads in member 4 for Prismatic Shaped Space Truss.	Fig.5.18

## **LIST OF SYMBOLS**

- E - Young's Modulus.
- A - Cross-sectional area of an element.
- L - Length of an element.

$[k^e]$  - Element stiffness matrix in the local coordinate system.

$\{u\}$  - Element displacements in local coordinate system.

$\{f\}$  - Element nodal force components in local coordinate system.

$[K]$  - Element stiffness matrix in the global coordinate system.

$\{U\}$  - Element displacement vector in global coordinate system.

$\{F\}$  - Element nodal force vector components in global coordinate system.

$N_i$  - Shape function for node  $i$ .

$u_i$  - Nodal displacement at nodes at local coordinate system.

$U_i$  - Displacement at joints in global coordinate system.

$\delta u$  - virtual displacement.

$P$  - Axial load.

$\epsilon_x$  - Strain component.

$[T]$  - Transformation matrix.

[K] - Element stiffness matrix in the global coordinate system.