# Table of Contents

<table>
<thead>
<tr>
<th>Number</th>
<th>Contents</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>الإابة</td>
<td>i</td>
</tr>
<tr>
<td></td>
<td>Dedication</td>
<td>ii</td>
</tr>
<tr>
<td></td>
<td>Acknowledgement</td>
<td>iii</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>iv</td>
</tr>
<tr>
<td></td>
<td>المستخلص</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Table of Contents</td>
<td>Vi</td>
</tr>
<tr>
<td></td>
<td>List of Figures</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>List of Tables</td>
<td>Xii</td>
</tr>
<tr>
<td></td>
<td>List of Abbreviations</td>
<td>xiii</td>
</tr>
</tbody>
</table>

## Chapter One – Introduction

1.1 Background  
1.2 Problem Statement  
1.3 Objectives  
1.4 Methodology  
1.5 Thesis Lay-out

## Chapter Two – Control System

2.1 Overview  
2.2 Conventional Control System Design  
2.2.1 Performance Objectives and Design Constraints  
2.2.2 Controller Design  
2.3 PID Controllers  
2.3.1 Importance of PID controller  
2.3.2 Three-term control
2.3.3 Parallel PID controllers 15
2.3.4 Series PID controllers 16
2.3.5 Tuning PID controller 17
2.3.6 Choosing the structure of a PID controller 20
2.4 Fuzzy Controller 20
  2.4.1 Fuzzy controller design 24
  2.4.2 Fuzzy set 25
  2.4.3 Linguistic variables 31
  2.4.4 Fuzzy rules 32
  2.4.5 Fuzzy implication 35
  2.4.6 Defuzzification 38
  2.4.7 Fuzzy controller structure 40
  2.4.8 Fuzzy supervisory control 42
  2.4.9 Supervision of conventional controllers 44
2.5 Fuzzy Tuning of PID Controllers 44
2.6 Cold Store 47
  2.6.1 Design and operation of components 49
  2.6.2 The refrigeration cycle 51
  2.6.3 Constructional features of the cold storage 52

**CHAPTER THREE – SIMULATION OF COLD STORE**

3.1 Fuzzy Auto-Tuning PID Control Algorithm 54
3.2 The Implementation Of Fuzzy Auto-Tuning PID Control 57
3.3 Temperature Control Method of the Cooling System 59
3.4 Simulation Method 59
### CHAPTER FOUR – SIMULATION RESULTS

| 4.1    | Results and Discussions | 62 |

### CHAPTER FIVE – CONCLUSION AND RECOMMENDATIONS

| 5.1    | Conclusion             | 68 |
| 5.2    | Recommendations         | 69 |