

# ***Dedication***

***To my beloved father***

***Mother***

***Brother***

***Sisters***

***And to my dear teachers and  
friends***

## **ACKNOWLEDGEMENT**

First of all I thank Allah. " The Greatest " for giving me physical and mental ability to conduct and finish this study successfully.

The following thesis. while an individual work, benefited from the insights direction of several people. I wish to express my sincere gratitude to all those who spared no effort to give best help and support to reach the stage of finalizing this study. I am indebted to many people directly and indirectly. I particularly thank the supervisor Dr. Elhadi Badawi Mahgoub who encouraged me to do the best.

Finally, Thanks to all my brothers and friends who have encouraged and helped me in my work.

## الخلاصة

نتيجة للنقص المتوقع للمصادر التقليدية للطاقة، تعتبر الطاقة الشمسية من الطاقات البديلة الأكثر أهمية و القابلة للتجديد، حيث أن استقلالها ليس خاضع للاعتبارات السياسية أو الاقتصادية وتحتاج فقط إلي أجهزة ضخمة لتجميع الإشعاع، تتناسب مع الكثافة المنخفضة من الطاقة لكل وحدة مساحة أو استخدام المجمعات الشمسية المركزة.

في هذه الدراسة تم تطوير برنامج باستخدام لغة Matlab لاستخدامه في حساب تصميم مجمع صحن شمسي ذو قطع مكافئ. هذا البرنامج يحسب أبعاد المجمع الشمسي باعتبار أن له معامل أداء 67% لكمية البخار المطلوبة عند الضغط ودرجة الحرارة المطلوبتين بمعرفة موقع التطبيق.

وقد تم وضع أمثلة لاختبار البرنامج وكانت النتائج المتحصل عليها إن قيمة القطر لمجمع صحن شمسي هي (253 - 758 متر) عندما نريد توليد كمية من البخار في مدي من (10 - 90 كجم/الثانية) توضح أن البرنامج يمكن استخدامه بنجاح في تصميم أبعاد مجمع الصحن الشمسي ذو القطع المكافئ.

## **Abstract**

Due to the expected shortage in conventional sources of energy, solar energy is considered the most important source of renewable energy which its usage is not subjected to political economical agenda, but required a huge equipment for collecting solar radiation proportional to the low intensity of energy per unit area.

In this research , a Matlab program was developed to be use for designing and calculation of a parabolic solar dish collector dimensions. This program calculated the dimension of such solar collector which is considered to have a coefficient of performance of 67% to produce the required steam at the required pressure and temperature by knowing the location of the application.

By testing the program, the program yields good results that validate the program and from it a value of the diameter in the range of (253-758 meter) is found, when we need to generate a quantity of steam in the range of (10 - 90 kg/s), results shows that the program could be used successfully in designing the dimension of the parabolic solar dish collector.

# Contents

<b>Subject</b>	<b>Page</b>
Dedication .....	I
ACKNOWLEDGEMENT .....	II
الخلاصة .....	III
Abstract .....	IV
Contents .....	V
List of Figures.....	VIII
List of Tables .....	x
CHAPTER ONE: INTRODUCTION.....	1
1-1 Background .....	1
1-2 Scope .....	2
1-3 Objectives.....	2
1-4 Methodology .....	2
1-5 Thesis Structure.....	3
CHAPTER TWO: SOLAR ENERGY AND SOLAR CONCENTRATION COLLECTOR .....	4
2-1 Sources of Energy .....	4
2-2 Renewable Energy.....	5
2-3 Solar Energy in the Sudan.....	5
2-4 Solar Energy Conversion .....	6
2-5 Solar Concentrating Collector .....	7
2-5-1 Preface .....	7
2-5-2 Parameters characterizing solar concentrators .....	8
2-5-3 Methods of classification .....	10

2-5-4 Linear imaging concentrators-geometry .....	15
<b>CHAPTER THREE: SOLAR-BEAM GEOMETRY AND TRACKING</b>	
<b>MODES .....</b>	<b>18</b>
3-1 Preface.....	18
3-2 The Sun .....	18
3-3 Motion of the Earth About the Sun .....	20
3-4 Solar Radiation Geometry .....	21
3-5 The Celestial Sphere and Basic Earth Sun Angles .....	22
3-6 Solar and Local Apparent Time .....	27
3-7 Orientation and Tracking Modes .....	28
3-8 Instruments for Measuring Solar Radiation and Sunshine.....	30
3-9 Solar Constant .....	32
<b>CHAPTER FOUR: RESEARCH METHODOLOGY.....</b>	
<b>34</b>	
4-1 Preface .....	34
4-2 Solar Parameters.....	35
4-3 Calculation of the Arrangement of Day in year.....	36
4-4 Calculations of Solar Time ( $S_{ot}$ ).....	36
4-5 Calculations of Solar Angles.....	37
4-6 Calculations of Solar Radiation.....	39
4-7 Design of the Solar Dish Collector.....	40
<b>CHAPTER FIVE: RESULTS AND DISCUSSION.....</b>	
<b>44</b>	
5-1 A Day in the Year.....	44
5-2 Solar Time ( $S_{ot}$ ).....	45
5-3 Solar Angles.....	45
5-4 Solar Radiation.....	50
5-5 Solar Dish Collector Design .....	51

5-5-1 Total solar energy required from the solar collector.....	51
5-5-2 Diameter of the compound solar collector.....	52
CHAPTER SIX: CONCLUSION AND RECOMMENATION.....	53
6-1 Conclusion.....	53
6-2 Recommendation.....	53
REFERENCES.....	54
Appendix.....	55

# List of Figures

<b>Figure</b>	<b>Page</b>
Figure (2-1) Flat-Plate Collector .....	11
Figure (2-2) Cylindrical Parabolic Collector .....	12
Figure (2-3) Compound Parabolic Collector.....	13
Figure (2-4) Parabolic Dish.....	14
Figure (2-5) Central receiver collector .....	15
Figure (2-6) Section of a linear parabolic concentrator showing major dimensions and the x,y,z coordinates .....	15
Figure (2-7) Image dimensions for a linear concentrator .....	16
Figure (2-8) Rim angle $\phi_r$ as a function of focal length-aperture ratio .....	17
Figure (3-1) Sun-Earth Relationships.....	19
Figure (3-2) Motion of the Earth About the Sun.....	20
Figure (3-3) The Basic Earth – Sun Angles.....	21
Figure (3-4) Celestial Sphere .....	22
Figure (3-5) Pyranometer For Measuring Global Radiation.....	31
Figure (3-6) Pyrheliometer for Measuring Beam Radiation .....	32
Figure (4-1) Flow chart.....	34
Figure (5-1) A day of the month corresponding to a day of the year .....	44
Figure (5-2) Solar time corresponding to a day of the year .....	45
Figure (5-3) Declination angle corresponding to a day of the year.....	46
Figure (5-4) Altitude angle corresponding to a day of the year.....	47
Figure (5-5) Azimuth angle corresponding to a day of the year .....	48



Figure (5-6) Incidence angle corresponding to a day of the year .....	49
Figure (5-7) $(I_{dn}), (I_{ds}), (I_t), (E_t)$ corresponding to a day of the year .....	50
Figure (5-8) $(Q_1), (Q_2), (Q_3), (Q_4), (E_{in})$ corresponding to the amount of vapour.....	51
Figure (5-9) Diameter and rise corresponding to the amount of vapour .....	52

# List of Table

<b>Table</b>	<b>Page</b>
Table (2-1) Typical temperature and range of concentration ratio of the various solar thermal .....	10
Table (4-1) Parameters for Solar Calculations (on the 21 day of each month).....	35
Table (4-2 ) Recommended average days for months and values of n by year.....	36

