

الآية

قال الله تعالى:

((وَقَضَىٰ رَبُّكَ أَلَّا تَعْبُدُوا إِلَّا إِيَّاهُ وَبِالْوَالِدَيْنِ إِحْسَانًا إِنَّمَا يَبْلُغَنَّ
عِنْدَكَ الْكِبَرَ أَحَدُهُمَا أَوْ كِلَاهُمَا فَلَا تَقُلْ لَهُمَا أُفٍّ وَلَا تَنْهَرْهُمَا
وَقُلْ لَهُمَا قَوْلًا كَرِيمًا . وَانْخَفِضْ لَهُمَا جَنَاحَ الذُّلِّ مِنَ الرَّحْمَةِ وَقُلْ
رَبِّ ارْحَمْهُمَا كَمَا رَبَّيَانِي صَغِيرًا. رَبُّكُمْ أَعْلَمُ بِمَا فِي نُفُوسِكُمْ
إِنْ تَكُونُوا صَالِحِينَ فَإِنَّهُ كَانَ لِلْأَوَّابِينَ غَفُورًا)).

الإسراء (23-25)

Dedication

"Success or failure is own decisions"

Every challenging work needs self efforts as well as guidance of elders especially those who were very close to our heart.

My humble effort I dedicate to my " family and friends " whose affection, love, encouragement and prays of day and night make me able to get such success and honor.

Along with all hard working and respected Teachers

Acknowledgement

Much of this work would have been impossible without the support, help and suggestions from our families and Teachers. In particular, we wish to thank **Dr Hassan Abdulateef Osman** for his efforts to give us the keys of this knowledge step by step and for his encouragement also **Eng Ayman Ibrahim Mohammed** who are responsible for the practical part of this project and for his encouragement and support throughout the preparation of this project .

We also wish to remember all invisible hands of the teachers of **School of Mechanical Engineering (SUST)**. We are privileged to know them.

Abstract

This study aimed at designing and selecting the Air-Conditioning system for Health Care hospital in accordance with international specifications and to what extends do hospitals in Sudan implement these specifications, this study adopted the descriptive and analytic method. It is also based upon information collected from secondary sources, firstly a research plan was put, the literature review had been done by researcher, then the description of the hospital and data analysis had been discussed, after that it will be clear to estimating the thermal load with computer program called hourly analysis program **(HAP)** version **4.61** and according to it the selection of the Air-Conditioning will take place.

التجريد

تبحث هذه الدراسة في تصميم واختيار منظومة تكييف لمستشفى هيلث كير بالمواصفات العالمية ومدى تطبيق مستشفيات السودان لهذا النظام, اتبعت الدراسة المنهج الوصفي والتحليلي وقد بنيت الدراسة علي المعلومات التي تم جمعها من المصادر الثانوية, لتنفيذ هذا المشروع اتبعت خطوات تتمثل في التالي , اولا تم وضع خطة لتنفيذ المشروع, ثم بعد ذلك تم تجميع عدد من الدراسات السابقة ذات الصلة بتكييف المستشفيات, ثم بعد ذلك سيصبح من الممكن تقدير الحمل الحراري للمبني وبناءا عليه سيتم اختيار منظومة التكييف للمستشفى.

Content of Tables

Table number	Subject	Page number
2.1	Typical applications of central systems	22
2.2	Typical application of decentralized systems	31
3.1	Number of equipments for each floor	39
3.2	The overall heat transfer coefficient for materials	39
3.3	Capacity of equipments	40
3.4	Number of people and activity level	41
3.5	Conduction heat transfer coefficient and thickness	41
3.6	Inside design parameters	43
4.1	Heat&cooling load for first floor	54
4.2	Heat&cooling load for second floor	55
4.3	Heat&cooling load for third floor	56
4.4	Heat & cooling load for operation room -01	57
4.5	Heat & cooling load for operation room -02	58
4.6	Heat & cooling load for CCU-ICU	59
4.7	Heat & cooling load for fourth floor	60
4.8	Heat & cooling load for fifth floor	61

Content of Figures

Figure number	Subject	Page
2-1	Air flow movement in rooms	8
2-2	Air flow configuration for critical areas	10
2-3a	Predicted velocity contours immune suppressed	11
2-3b	Temperature contours in immune suppressed penitent room	11
2-4a	Air flow distribution in operating theatre open heart surgery	12
2-4b	Temperature in operating theatre open heart surgery	12
2-5	Different configuration of surgical operating theatres	14
2-6	Typical chilled water	15
2-7	Typical window unit	23
2-8	Typical split unit arrangement	24
2-9	VRF system	26
2-10	Package type split system	27
2-11	Package terminal air conditioners	28
2-12	Typical single-package rooftop system	29

Table of Abbreviation Definition

Abbreviation	Definition
HVAC	Heating, ventilation and air conditioning
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ACH	Air Change per Hour
AIA	American Institute of Architect's
NFPA	National Fire Protection Association
NFPA	National Fire Protection Association
CDC	Centers for Disease Control and Prevention
ICBO	International conference of building officials
LCCA	life-cycle cost analysis
DB	dry-bulb
MWB	mean coincident wet-bulb
EP	Emergency power
SMACNA	Sheet metal and air conditioning contractor's national association
DX	direct expansion
AHUs	air-handling units
TR	Ton of Refrigeration
BTU	British thermal unit
COP	coefficient of performance
CAV	Constant air volume
VAV	Variable Air Volume
VRF	Variable Refrigerant Flow
CFM	cubic feet per minute
PTAC	Package terminal air conditioners
HEPA	high efficiency particulate air
ULPA	Ultra low particular air
BOCA	Building officials code administrators international
IAQ	Indoor Air Quality

Table of contents

number	Subject	page
	Dedication	
1	Acknowledgment	1
2	Abstract	2
3	Abstract in Arabic	2
4	Table of content	2
5	Table of abbreviation definition	
6	Tables	
7	Content of figures	
8	Table of contents	
Chapter one: introduction		
9	Introduction	2
10	Research problem	3
11	Research objectives	3
12	Research methodology	4
Chapter Two: Literature review		
13	Environmental Control	7
14	Design Specifications	9
15	Chilled Water System	15
16	Condenser Water System	16
17	Air Delivery System	17
18	Central system	18
19	Constant air volume (CAV) system	18
20	Variable Air Volume (VAV) system	18
21	All-Water Systems	20
22	Typical Applications of Central Systems	21

23	Decentralize system	22
24	Window Air Conditioner	23
25	Split Air conditioning Systems	23
26	Variable Refrigerant Flow (VRF) Split System	24
27	Packaged Air Conditioners	26
28	Package terminal air conditioners (PTAC)	28
29	Single package rooftop systems	29
30	Heat Pumps	29
31	Heat Rejection	30
32	Typical Applications	30
Chapter Three: Description of health care hospital		
33	Hospitals Survey	34
34	Description of health care hospital	36
35	Outside design conditions	42
36	Inside Design Conditions	42
37	Heat load calculation equations	43
Chapter Four: Heat load calculations		
38	Introduction for Hourly Analysis Program (HAP)	49
39	Load calculations	50
40	tables of heating and cooling load calculation	51
Chapter Five: Conclusion& Recommendations		
41	Conclusion	65
42	Recommendations	66
43	REFERENCES	67
44	Appendices	68