DECLARATION

I declare that this project entitled "Cooling Load Estimation Using Multimedia Facilities for Educational Purpose" is the result of my own work except as cited in the references.

Signature : .....

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Date : 5/7/2017

SUPERVISOR'S DECLARATION

I have checked this report and the report can now be submitted to JK-PSM to be delivered back to supervisor and to the second examiner.

Signature :.....

Name of Supervisor :Prof Md Razali bin Ayob

Date :5/7/2017

DEDICATION

I dedicate this project to my beloved mother, Noriah Binti Basir who always have been supporting me throughout and to my respected late father, Mohd Anasir bin Ab. Rahman who raise and supported me with much care and love during his lifetime and also to my family members who encourage me to give my best. I am also thankful and honored to have Prof. Dr Md. Razali Ayob as my supervisor for his guide and ideas helps me a lot throughout completing this project. Much appreciation to my friends that helps me with suggestion for this project.

ABSTRACT

Heating, Ventilating and Air Conditioning (HVAC) system is a system which function to treat the air and transmit the treated air to a specific location. However, the primary energy may continue to increase due to the change of climate and demands for a more comfortable surroundings. The cooling load estimation is an important factor to be consider in order to operate the HVAC system efficiently which may lead to energy saving measures. For engineering students, the cooling load estimation studies may give them a hard time to comprehend as the estimation of cooling load involves many variables and factors as well as complex formula during the studies. Subsequently, this project is conducted to propose a multimedia platform for cooling load estimation studies and to create an internet-based learning platform and provide the student with an interactive ways of learning the cooling load estimation studies in order to enhance their knowledge.

ABSTRAK

Sistem Pemanas, Ganti Udara dan Penyaman Udara (HVAC) adalah satu sistem yang berfungsi untuk merawat udara dan menghantar udara yang telah dirawat ke lokasi tertentu. Walau bagaimanapun, tenaga utama boleh terus meningkat disebabkan oleh perubahan iklim dan permintaan untuk persekitaran yang lebih selesa. Beban anggaran penyejukan adalah faktor penting yang perlu dipertimbangkan untuk mengendalikan sistem HVAC dengan cekap yang boleh membawa kepada langkah-langkah penjimatan tenaga. Untuk pelajar kejuruteraan, kajian beban anggaran penyejukan boleh memberikan mereka masa yang sukar untuk memahami kerana anggaran beban penyejukan melibatkan banyak pembolehubah dan faktor-faktor serta formula yang kompleks semasa proses pembelajaran. Oleh itu, projek ini dijalankan untuk mencadangkan satu platform multimedia untunk digunakan berkaitan dengan beban anggaran penyejukan dan untuk mewujudkan satu platform pembelajaran berasaskan internet dan menyediakan pelajar dengan medium pembelajaran yang interaktif berkaitan dengan kajian beban anggaran penyejukan dalam usaha untuk meningkatkan pengetahuan mereka.

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HVAC	Heating Ventilation Air Conditioning
TRNSYS	Transient System Simulation Program
MOOC	Massive Open Online Course
CLTD	Cooling Load Temperature Difference
CLF	Cooling Load Factor
SCL	Solar Cooling Load Factor
ACH	Number of Air Changes per Hour
SC	Shading Coefficient

LIST OF SYMBOL

$Q_{conductive}$	=	Glass conductive load
Q_{solar}	=	Glass solar transmission
U	=	Overall heat transfer coefficient
Q_{wall}	=	Heat transmission for wall
A	=	Area
Q_s	=	Sensible heat gain
Q_l	=	Latent heat gain
$Q_{s,inf}$	=	Sensible heat gain due to infiltration
$Q_{l,inf}$	=	Latent heat gain due to infiltration
V_{inf}	=	Amount of infiltrated air
t_o	=	Outside air temperature
t_i	=	Inside air temperature
ω_o	=	specific humidity of outside air
ω_i	=	specific humidity of inside air
N	=	number of occupant

CHAPTER 1

INTRODUCTION

1.1 Background

Heating, Ventilating and Air Conditioning (HVAC) systems account for more than 50% of the total energy consumed in the building sector which substantial to enhance indoor thermal comfort. It is notable that the primary energy consumption may continue to increase due to the change in climate and rising living standard. Prediction of cooling load is crucial in order to operate HVAC system efficiently which may lead to energy-saving measures. Cooling load is the rate which a system remove sensible and latent heat from a conditioned zone to maintain it at a constant dry bulb temperature and humidity (Kreider et al. 1978).

In recent years, academic infrastructure were built and equipped with a centralized HVAC system. The academic infrastructure however are not always occupied and thus have an intermittent cooling load pattern. This pattern is also due to the change of occupancy for every semester or academic year which may decrease or increase respectively (Petrus Tri Bhaskoro et al., 2013). According to Yan Ding and Wei Feng (2016), the cooling load of a building is affected by behaviour of occupants and the equipment to enhance human comfort in indoor environment. They added that, due to this factor the existing method in evaluating the cooling load for irregular occupancy are still lacking.

Generally, cooling load estimation can be divided into two categories, which are statistical method and building simulation program (Lin Duanmu et al., 2013). Statistical method is a method which relies on the data collection and analysis of large amount of energy consumption hourly. Example of statistical method includes liner regression, exponential smoothing, "gray box" theory, neural networks and the combination of one or more of the analysis method listed earlier. The hourly data collected is valuable for predicting energy usage of building with similar properties (size, function etc.). However, this method is hardly applicable due to diversity of building climate and high operation cost. In China, the data collection of the building only occurs at peak time and not collected hourly.

As for building simulation programme, several building details are required to predict the cooling load of the building such as materials, building geometry and schedule (electrical appliances, occupant). Example of building simulation programme that is available includes DOE-2, Energy-Plus, TRNSYS and HTB2 (Lin Duanmu et al., 2013). A study of cooling load prediction was proven to be worthwhile in increasing indoor thermal comfort in a confined space.

1.2 Problem Statement

The cooling load estimation plays a significant role in the HVAC system in order to control the efficiency and maintaining the thermal comfort of occupant. Through the studies of cooling load, student or future engineers are able to

understand the concept and mechanism involved in the cooling load estimation which later can be applied in their field of work. For engineering students, the study about cooling load estimation is covered in the Heating, Ventilating and Air Conditioning (HVAC) course.

The conventional way in learning of related courses is through attending lecture session in class and through the practical practice for the laboratory session. Most of the time, lecturer will deliver instructions and guide the student in the class orally. However, some students lack an effective listening skill and concentration to comprehend and unable to understand the instruction given at their full content (Morreale et al., 2000). This may lead to misunderstanding and wrong information regarding the subject is conveyed among the students. Hence, results in students failed to apply and practice what they have learnt during their study years when they are working in the industry.

It is only correct to emphasize and utilize the use of multimedia facilities to enhance the learning session. In cooling load estimation studies, students are exposed to a variety of formulas and calculation which might be a hard thing to digest if relying on lecture alone. With interactive features of the multimedia facilities such as videos, student will be able to comprehend and remembers more vividly about things they learn through the multimedia.

1.3 Objective

This project aims to propose an interactive multimedia platform for educational purpose in engineering field regarding the cooling load estimation studies. The second objective is to establish an open-access internet-based learning platform for the cooling load estimation studies.

1.4 Scope of Project

The scope of the project covers the study on HVAC cooling load estimation and the OPENLEARNING™ multimedia platform. OPENLEARNING™ is also an internet-based platform for education in which it supports the Massive Open Online Course (MOOC). The syllabus for cooling load estimation used in this project refers to the standard syllabus of the refrigeration and air conditioning system subject.

CHAPTER 2

LITERATURE REVIEW

In order to determine the cooling load in a certain confined building space, it is essential to gain an understanding regarding the related properties of the cooling load. The related properties include the definition of related terms, the component in the cooling load etc. By knowing the related properties of the cooling load, it will ensure a better understanding on what the cooling load is about and provides a better perspective on how to estimate the cooling load in a confined space.

2.1 Terms Definition

There are four crucial heat flow terms which is related for calculating cooling load which are space cooling load, heat gain, space heat extraction rate and cooling coil load (McQuinston and Spitler., 1992). Cooling load is defined as the rate at which heat must be removed out of a building in order to keep the indoor temperature at the design value. It was stated that there is a difference between space heat gain and space cooling load and it is wrong to denotes that both properties is similar even it may seem identically logical.

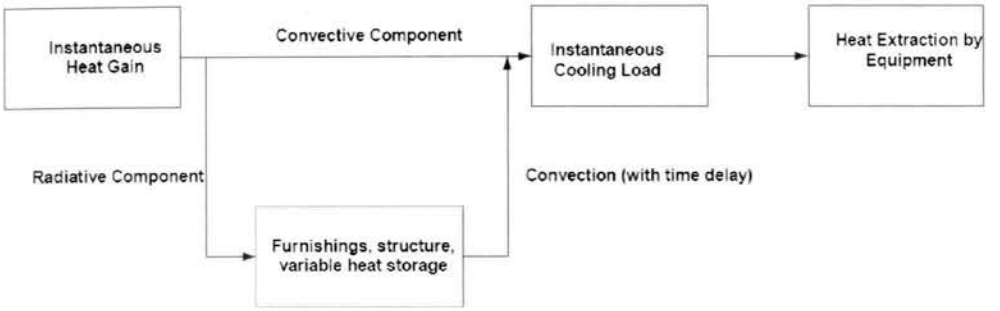

Figure 1: Schematic Relation between Heat Gain and Cooling Load

Heat gains which transferred into a building are absorbed and trapped in the surface of the confined space (floor, walls etc.) and also by the objects in the space such as furniture, curtains, etc. Even after the heat gain source is no longer available, these substances will still radiates heat into the space. This thermal effect is essential for the determination of instantaneous heat gain and cooling load for a space at a specific time. Convection of heat flows is converted into space cooling load instantaneously but the radiant loads have a tendency to be stored partially in a building. Cooling load is denotes as the summation of all instantaneous heat gain plus the radiant energy which was absorbed by the confined space surface. This suggests that cooling load and heat gain is not the same. However, the space heating load can be equated to the instantaneous heat loss in heating load calculations which may be use directly to determine the heating equipment sizing.

Cooling coil load is the summation of all cooling loads of various spaces involved by the equipment and any external loads to the space such as fan heat, duck leakage, duct heat gain and outdoor makeup air. Space heat extraction is usually assumed same as space cooling load only if the space temperature remains constant (A.Bhatia.,2012).

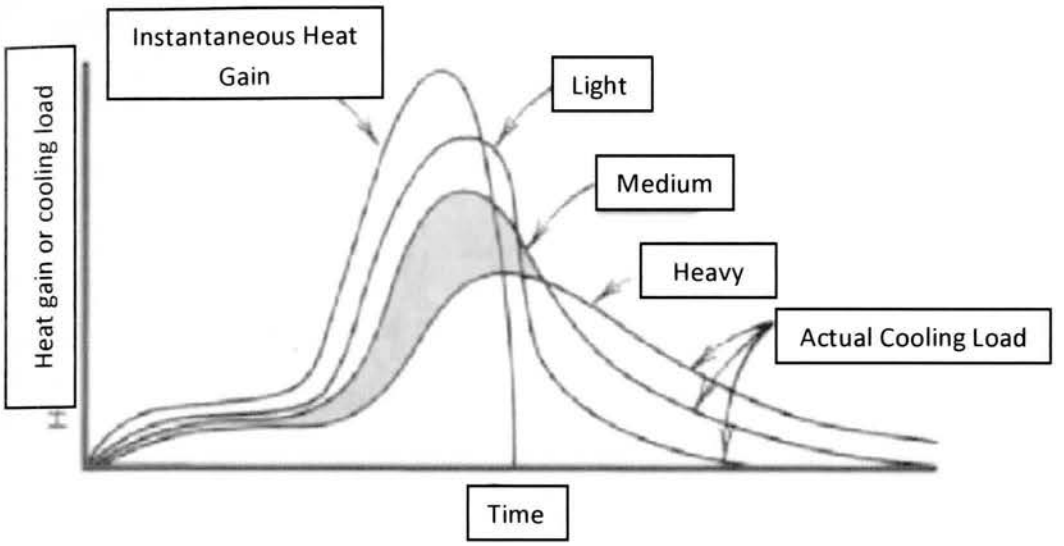

Figure 2: Sensible Heat Gain

2.2 Factors which Contributes to Human Comfort

Human comfort or also known as Thermal Comfort is a condition where most people are comfortable with the surrounding environment most of the time. The basic condition in which human is comfortable are as follows (Olsen et al, 2004);

a) Temperature of air — 22-26°C.

b) The relative humidity — 30-70%

c) Velocity of air — 0.25m/s

2.3 Factors Contributing to Cooling Load Changes.

Cooling and heating load calculation is necessary in sizing the HVAC system and their respective components. The loads are calculated to ensure the indoor design

condition to be maintained at a comfortable region. However, we need to take into account the factors which might affect our calculation. Such factors are as the following;

a) Condition of the specified location. (latitude, longitude, wind velocity, precipitation etc.)
b) Outdoor design conditions (temperature, humidity etc)
c) Indoor design conditions.
d) Building details (material, size and shape)
e) Site configuration (orientation, shading and location)
f) Operating schedules (lighting, occupancy and equipment)
g) Additional factors for consideration (type of air-conditioning system, fan energy, fan location, duct heat loss and gain, duct leakage, type and position of air return system).

2.4 Climate Effect on Cooling Load

It is important to know that the term "climate" and "weather" refers to two different conditions. Climate can be defined as the integration in time of weather conditions, characteristics of a certain geographical location. Meanwhile, weather refers to the prevailing set of atmospheric conditions at a given place and time. Climate portrays a significant effect on building performance, energy consumption and HVAC design. The key factor of climatic design includes the following;

a) To diminish the cost spend for energy of a specified building

b) To reduce the reliability on mechanical system power and harness the "natural energy" as much as possible.

c) To guarantee healthy and pleasant environment to the occupant.

Climate can be grouped into four major categories for the reference when calculating the cooling load. These categories are;

a) Hot-dry climates — overheating problem is the main concern. Nevertheless, the dry air permits the evaporative cooling mechanism of the body. There is an existence of a large diurnal (day-night) temperature difference.

b) Warm-humid climate — a condition in which the temperature is not approximately as high as in hot-dry area but due to the high humidity, the evaporation potential is limited. The diurnal temperature variation is significantly small

c) Cold climates — the occurrences under heating (lack of heat) is the main concern.

d) Temperature climates — a condition where the temperature of an area are not too hot or too cold.

2.5 Cooling Load Classification by Source

According to A. Bhatia., 2012, cooling can be group into four categories according to their sources which are;

a) Internal heat gains that is produced by peoples in a confined space, by indoor apparatus and appliances, lights and machinery

b) Solar heat gains through a see-through material (radiation).

c) Heat transfer by conduction through building surface or skin as a result of the indoor-outdoor temperature difference.

d) Heat gains from air ventilation system or infiltration of outside air into the space.

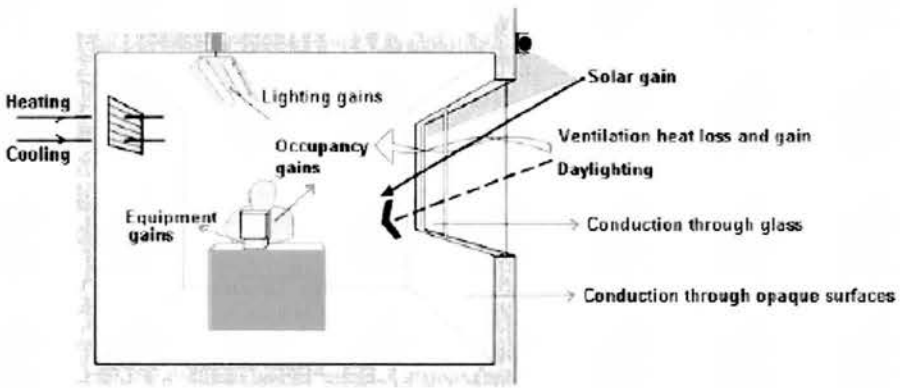

Figure 3: Source of Cooling Load

2.6 Classification of Cooling Load According to Type of Heat.

Cooling loads can be further categorized by type of heat which is the sensible load (heat gain) and the latent load (water vapour gain).

Sensible load is the heat that is added to the space directly which cause a rise in the space temperature (A. Bhatia., 2012). Sensible load affects the dry bulb temperature. Factors that influence the sensible loads include the followings;