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PERFORMANCE EVALUATION OF DC MACHINE

SITI MARIAM BINTI SHAFIE

POWER ELECTRONICS AND DRIVES

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PERFORMANCE EVALUATION OF DC MACHINE

SITI MARIAM BINTI SHAFIE

This Report Is Submitted In Partial Fulfillment of Requirements for the Degree of Bachelor in Electrical Engineering (Power Electronics and Drives)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APRIL 2009

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"I hereby declared that I have read through this report entitle "Performance Evaluation of DC Machine" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Power Electronics and Drives)."

Signature :

Supervisor's Name : MRS. WAHIDAH BINTI ABDUL HALIM

Date : APRIL 2009

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"I declare that this report entitle "Performance Evaluation of DC Machine" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any degree.

Signature :

Name : SITI MARIAM BINTI SHAFIE

Date : APRIL 2009

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To

Mom and Dad

Your prayers keep me moving forward

Teachers

Fill my heart with the truth and knowledge

Beloved friends

Make my world happens

Every Muslims

May Allah bless you all here and hereafter

-Al-fatihah-

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In the name of Allah, The Most Gracious, The Most Merciful. Peace be upon the Messenger of Allah, Prophet Muhammad s.a.w, his companions (r.a) and followers until the end of day. Thanks to Allah, with His blessing, this final project is successfully delivered following to the due date time.

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ABSTRACT

The purpose of this project is to study the performance of DC machine. Beyond this project, the main objectives that going to be achieve are to study the real functional and characteristic of DC machines including calculation, waveform, circuit drawing, physical construction of motor and others related. An electric machine is a device that can convert either mechanical energy to electric energy or electric energy to mechanical energy. When such a device is used to convert mechanical energy to electrical energy, it is called a generator. When it converts electric energy to mechanical energy, it is called a motor. There are five major types of dc motors and dc generators in general use. Meanwhile, DC generator also involves five types based on their applications. DC motors are often compared by their speed regulations. Then, DC generators are compared by their voltages, power ratings, efficiencies, and voltage regulations. Besides familiar with the machines, the other objective is to aim the development and analysis characteristic of DC motor from Lab View software. This because, this project will be implement with development of Lab View software. The reason of using Lab view software is to learn and explore more about motor characteristics in animation view obviously.

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ABSTRAK

Projek ini adalah bertujuan untuk mempelajari serta memahami sifat dan ciri-ciri motor arus terus dan generator arus terus. Melalui projek ini, objektif utama yang akan dicapai ialah untuk mempelajari operasi mesin arus terus termasuk persamaan, litar setara, binaan mesin secara fizikal serta ciri-ciri lain yang berkaitan. Mesin adalah peranti yang mana boleh menukarkan sama ada tenaga mekanikal kepada tenaga elektrik atau tenaga elektrik kepada tenaga mekanikal. Apabila peranti itu digunakan untuk menukarkan tenaga mekanikal kepada tenaga elektrik, ia bertindak sebagai generator. Manakala, apabila peranti itu digunakan untuk menukarkan tenaga elektrik kepada tenaga mekanikal, ia bertindak sebagai motor. Oleh sebab itu, mesin elektrik boleh bertindak sebagai motor atau generator. Dalam kegunaan industri, terdapat lima jenis motor arus terus. Manakala, generator arus terus juga melibatkan jenis yang sama berdasarkan kegunaan masing-masing. Motor arus terus biasanya dibandingkan dengan kelajuan. Manakala, generator arus terus dibandingkan dengan voltan, kuasa, kecekapan dan pengaturan voltan. Di samping memahami mesin elektrik ini, objektif lain yang ingin turut dicapai ialah membuat analisis ciri-ciri mesin dengan penggunaan perisian Lab View. Ini kerana, dalam projek ini segala analisis dan ciri-ciri akan digunakan dengan bantuan Lab View sebagai perisian bantuan yang utama. Sebab utama menggunakan perisian ini adalah, pelajar boleh mempelajari, serta menerokai dengan lebih mendalam tentang ciri-ciri motor dan generator dalam bentuk gambaran animasi, pengukuran dan automasi.

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LIST OF SYMBOLS

DC	-	Direct Current
AC	-	Alternative Current
PWM	-	Pulse Width Modulation
T	-	Torque
F	-	Force
r	-	Radius
Nm	-	Newton Meter
W	-	Angular Velocity
V	-	Velocity
W	-	Watts
VI	-	Virtual Instrument
GUI	-	Graphical User Interface

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CHAPTER 1

INTRODUCTION

1.1 Project Background

The purpose of this project is to study the characteristics and performance of DC machine .The characteristics consists of output power, output torque, speed, input current, efficiency, input voltage and shunt excitation. All of these characteristics have been performing in graph characteristics according to the machine.

The experimental session has been done to collect all the information about the characteristics of DC machine. From the information collected, simulation is developed in respect to show precisely the relationship between each correspondent output of the DC machine.

1.2 Objective of the Project

The objectives of the project basically to overcome on the problems occur. The first objectives are to study and become familiar with the characteristics of DC machines which are referring on DC motor and DC generator. However, these projects are focusing on the DC motor itself.

The case study is including the characteristics of speed, torque, equivalent circuit, waveform, etc. Besides that, the second objectives that going to be achieve is to develop and analyze DC machines performance from Lab view software simulation.

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Thus, the objectives of the projects is;-

i. To develop and analyze DC machine performance using Lab View software.
ii. To study the operating characteristic of DC machine. It will focus on the three DC motor.
iii. To calculate data define by equation through Lab View software such as torque, nominal displacement, efficiency and etc.
iv. To design GUI panel using Lab View software as interactive learning syllabus through software application.

1.3 Problem statement

Direct current machines are widely used in motion control applications. The DC drive is relatively simple and cheap (compared to induction motor drives). But DC motor itself is more expensive. Due to the numerous disadvantages of DC motor (esp. maintenance), it is getting less popular, particularly in high power applications. For low power applications the cost of DC motor plus drives is still economical. For servo application, DC drives is still popular because of good dynamic response and ease of control. So that is good reason for us to study and explore the machine behavior in order to apply the applications through the suitable applications.

Currently, in UTeM faculties, especially electrical faculties, students are basically can learn, study and explore about the motor, generator or machine specifications through the syllabus provided by faculties. In order to fulfill the syllabus requirement, student ought to follow the syllabus given where is attend class, tutorial and laboratory experiment. By laboratory experiment task, student can learn and explore wisely the subject where they can see clearly the motion of the motor, and the data collected by doing the experiment task. Due this scenario, however, by observation, there are several problem consists while the experiment done. In normal situation, by experiment a few of problem always occur in different ways. This occurrence of course, sometimes cannot be avoided wisely.

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The problems occur can be categorized such as;

1. Inaccurate data due to equipment error
2. High maintenance for damaged equipment
3. High cost for replaced equipment (machines, motor, etc)
4. High power consumption in operating the machine
5. Force of human labors or force of energy.

Based on the problems above, these problems can be solving wisely through software implement. This because the consideration of choosing Lab view software is important to overcome the problems. In addition to that, besides manual experiment in laboratory, a software usage also needed as an important and second solution to find the experiment results. With this software, the overall characteristics that going to be analyzes such as speed, torque, can be simply analytically.

As a comparison, sometimes, by manual experiment the result cannot show directly the process of waveform and the overall inner characteristics during handling experiment. However, compare using this Lab view software, it totally can demonstrate the real of process whereby the results evaluate such as waveform criteria, the circuit of motor and etc.

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1.4 Scope of the project

As a whole, these projects actually focusing on three DC motor where is already selected from the others types of DC machines. Then, the experiment session and analysis has been done of these three of motors and then evaluating the operating characteristics behavior.

The selected DC motors are following;

1. Shunt Excited DC motor
2. Series Excited DC motor
3. Compound Excited DC motor (cumulative short shunt)

1.5 Report Outline

Chapter 1 explained the project background, objective of the project, problem statement and also the scope of the project.

Chapter 2 is exposed about all of literature review of DC machine. This chapter discuss about the motor characteristics including its application.

Chapter 3 described in details the methodology of the project. The software used is Lab View software application. The details of experimental procedure also had been discussed.

Chapter 4 described details the results of the project, including graph characteristics performing. The performance analysis of the implemented project of the also is discussed.

Chapter 5 discussed about the recommendation for the future work and also the conclusion of the project.

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CHAPTER 2

THEORY AND LITERATURE REVIEW

2.1 Introduction

In today's world, almost all land-based electrical power supply networks are AC systems of generation, transformation, transmission and distribution. Thus there is little need for large DC generators. Furthermore, AC motors are used in industries wherever they are suitable or can give appropriate characteristics by means of power electronic devices. Yet there remain important fields of application when the DC machines can offer economic and technical advantage. The wonderful thing about DC machines is its versatility.

Electric Motors and Generators, group of devices used to convert mechanical energy into electrical energy, or electrical energy into mechanical energy, by electromagnetic means. A machine that converts mechanical energy into electrical energy is called a generator, alternator, or dynamo, and a machine that converts electrical energy into mechanical energy is called a motor.

Direct-current (DC) machines are driven from a DC power supply. DC machines are the most versatile of all rotating electrical machines. Their speed may be easily adjusted in very fine increments ranging from standstill to rated speed and even above. The DC drive is relatively simple and cheap (compared to induction motor drives). But DC motor itself is more expensive. For low power applications the cost of DC motor plus drives is still economical. For servo application, DC drives is still popular because of good dynamic response and ease of control.

The DC machine is popular in a number of drive applications due to its simple operation and control. The starting torque of dc machine is large, which is the main reason

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for using it in several traction applications. A special form of DC machine can also be used at home, such as circular saws and blenders are DC machines. The regular main components of the DC machine are field circuit, armature circuit, commutator, and brushes. The field is normally an electric magnet fed by a DC power source. In small machines, the field is often permanent. The armature circuit is composed of the windings, commutator are mounted on the rotor shaft and therefore rotate. The brushes are mounted on the stator and are stationary, but in contract with the rotating commutator segments. The rotor windings are composed of several coils ; each has two terminals connected to the commutator segments on opposite sides. The commutator segments are electrically isolated from one another. The segments are exposed, and the brushes touch two opposing segments. The brushes allow the commutator segments to be connected to an external DC source.

2.2 History and development of DC machine

Electric motors of increasing efficiency were constructed throughout the 19th century, but commercial exploitation of electric motors on a large scale required efficient electrical generators and electrical distribution networks. Before the usage of applications of DC machine, there are history and development of DC machine itself.

2.2.1 The principle of DC machine

The principle of conversion of electrical energy into mechanical energy by electromagnetic means was demonstrated by the British scientist Michael Faraday in 1821 and consisted of a free-hanging wire dipping into a pool of mercury. A permanent magnet was placed in the middle of the pool of mercury. When a current was passed through the wire, the wire rotated around the magnet, showing that the current gave rise to a circular magnetic field around the wire. This motor is often demonstrated in school physics classes, but brine (salt water) is sometimes used in place of the toxic mercury. This is the simplest form of a class of electric motors called homopolar motors. A later refinement is the Barlow's Wheel. These were demonstration devices, unsuited to practical applications due to limited power [1].

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