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Lab Manual:

DC Machines Laboratory (AAEC09)

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Contents

Content **iv**

1 LAB-1 ORIENTATION **5**
1.1 Introduction 5
1.2 Objective 5
1.3 Prelab Preparation: 5
1.4 Equipment needed 5
1.5 Procedure 5

2 LAB-2 MAGNETIZATION CHARACTERISTIC OF DC SHUNT GENERATOR **6**
2.1 Introduction 6
2.2 Objective 6
2.3 Prelab Preparation: 6
2.4 Equipment needed 6
2.5 Background 6
2.6 Procedure 7
2.7 Model graphs 8
2.8 Probing Further Experiments 8

3 LAB-3 LOAD TEST ON DC SHUNT GENERATOR **9**
3.1 Introduction 9
3.2 Objective 9
3.3 Prelab Preparation: 9
3.4 Equipment needed 9
3.5 Background 9
3.6 Procedure 10
3.7 Model graphs 11
3.8 Probing Further Experiments 11

4 LAB-4 LOAD TEST ON DC SERIES GENERATOR **12**
4.1 Introduction 12
4.2 Objective 12
4.3 Prelab Preparation: 12
4.4 Equipment needed 12
4.5 Background 12
4.6 Procedure 13
4.7 Model graphs 14
4.8 Probing Further Experiments 14

5 LAB-5 LOAD TEST ON DC COMPOUND GENERATOR **15**
5.1 Introduction 15
5.2 Objective 15

5.3 Prelab Preparation: 15
5.4 Equipment needed 15
5.5 Background 15
5.6 Procedure 16
5.7 Model graphs 17
5.8 Probing Further Experiments 17

6 LAB-6 HOPKINSON'S TEST ON DC SHUNT MACHINES 18
6.1 Introduction 18
6.2 Objective 18
6.3 Prelab Preparation: 18
6.4 Equipment needed 18
6.5 Background 18
6.6 Procedure 19
6.7 Calculations 20
6.8 Tabular column 20
6.9 Model graphs 21
6.10 Probing Further Experiments 21

7 LAB-7 FIELD TEST ON DC SERIES MACHINES 22
7.1 Introduction 22
7.2 Objective 22
7.3 Prelab Preparation: 22
7.4 Equipment needed 22
7.5 Background 22
7.6 Procedure 23
7.7 Calculations 24
7.8 Probing Further Experiments 24

8 LAB-8 SPEED CONTROL OF DC SHUNT MOTOR AND SWINBURNE'S TEST ON DC SHUNT MOTOR 25
8.1 Introduction 25
8.2 Objective 25
8.3 Prelab Preparation: 25
8.4 Equipment needed 25
8.5 Background 25
8.6 Procedure 26
8.7 Model graphs 27
8.8 Model graphs 27
8.9 Probing Further Experiments 27

9 LAB-9 BRAKE TEST ON DC COMPOUND MOTOR 28
9.1 Introduction 28
9.2 Objective 28
9.3 Prelab Preparation: 28
9.4 Equipment needed 28
9.5 Background 28
9.6 Procedure 29
9.7 Calculations 30
9.8 Model graphs 30
9.9 Probing Further Experiments 30

10 LAB-10 BRAKE TEST ON A DC SHUNT MOTOR **31**
10.1 Introduction . . . 31
10.2 Objective . . . 31
10.3 Prelab Preparation: . . . 31
10.4 Equipment needed . . . 31
10.5 Background . . . 31
10.6 Procedure . . . 32
10.7 Calculations . . . 33
10.8 Model graphs . . . 33
10.9 Probing Further Experiments . . . 33

11 LAB-11 RETARDATION TEST **34**
11.1 Introduction . . . 34
11.2 Objective . . . 34
11.3 Prelab Preparation: . . . 34
11.4 Equipment needed . . . 34
11.5 Background . . . 34
11.6 Procedure . . . 35
11.7 Calculations . . . 36
11.8 Probing Further Experiments . . . 37

12 LAB-12 SEPARATION OF CORE LOSSES IN DC SHUNT MOTOR **38**
12.1 Introduction . . . 38
12.2 Objective . . . 38
12.3 Prelab Preparation: . . . 38
12.4 Equipment needed . . . 38
12.5 Background . . . 38
12.6 Procedure . . . 39
12.7 Calculations . . . 40
12.8 Model graphs . . . 41
12.9 Probing Further Experiments . . . 41

13 LAB-13 MAGNETIZATION CHARACTERISTIC OF DC SHUNT GENERATOR BY USING DIGITAL SIMULATION **42**
13.1 Introduction . . . 42
13.2 Objective . . . 42
13.3 Prelab Preparation: . . . 42
13.4 Equipment needed . . . 42
13.5 Background . . . 42
13.6 Procedure . . . 42
13.7 Model graphs . . . 43
13.8 Probing Further Experiments . . . 44

14 LAB-14 LOAD TEST ON DC SHUNT GENERATOR BY USING DIGITAL SIMULATION **45**
14.1 Introduction . . . 45
14.2 Objective . . . 45
14.3 Prelab Preparation: . . . 45
14.4 Equipment needed . . . 45
14.5 Background . . . 45
14.6 Procedure . . . 45
14.7 Model graphs . . . 46

14.8 Probing Further Experiments 47

INTRODUCTION

Introduction

DC Machines laboratory Practice is intended to enhance the learning experience of the student about DC machines constructions and characteristics. This lab is to expose the students to the operation of Electrical machine lab-I and give them experimental skill. It also aims to understand the generation of DC voltages by using different types of generators and study their performance and enable the students to understand the working principles of DC motors and their load characteristics, starting and methods of speed control. Further it helps to familiarize with the constructional details of different types of DC generators, DC motors working principle and their performance. How the student performs in the lab depends on his/her preparation, participation, and team work. Each team member must participate in all aspects of the lab to insure a thorough understanding of the equipment and concepts. The student, lab teaching assistant, and faculty coordinator all have certain responsibilities toward successful completion of the lab's goals and objectives.

Student Responsibilities

The student is expected tocome prepared for each lab.Lab preparation includes understanding the labexperiment from the lab manual and reading the related textbook material.

Students have to write the allotted experiment for that particular week in the work sheets given and carry them to the Lab. In case of any questions or problems with the preparation, students can contact the Faculty Teaching the Lab course, but in a timely manner.

Students have to be in formal dress code, wear shoes and lab coat for the Laboratory Class.

After the demonstration of experiment by the faculty, student has to perform the experiment individually. They have to note down the observations in the observation Tables drawn in work sheets, do the calculations and analyze the results.

Active participation by each student in lab activities is expected. The student is expected to ask the Faculty any questions they may have related to the experiment.

The student should remain alert and use commonsense while performing the lab experiment.They are also responsible for keeping a professional and accurate record of the labexperiments in the files provided.

Responsibilities of Faculty Teaching the Lab Course

The Faculty shall be completely familiar with each labprior to the laboratory. He/She shall provide the students with details regarding the syllabus and safety review during the first week.Lab experiments should be checked in advance to make sure that everything is in working order.The Faculty should demonstrate and explain the experiment and answer any questions posed by the students.Faculty have to supervise the students while they perform the lab experiments. The Faculty is expected to evaluate the lab worksheets and grade them based on their practical skills and understanding of the experiment by taking Viva Voce. Evaluation of work sheets has to be done in a fair and timely manner to enable the students, for uploading them online through their CMS login within the stipulated time.

Laboratory In-charge Responsibilities

The Laboratory In-charge should ensure that the laboratory is properly equipped, i.e., the Faculty teaching the lab receive any equipment/components necessary to perform the experiments.He/She is responsible for ensuring that all the necessary equipment for the lab is available and in working condition. The Laboratory In-charge is responsible for resolving any problems that are identified by the teaching Faculty or the students.

Course Coordinator Responsibilities

The course coordinator is responsible fo rmaking any necessary corrections in Course Description and lab manual. He/She has to ensure that it is continually updated and available to the students in the CMS learning Portal.

Lab Policy and Grading

The student should understand the following policy:

ATTENDANCE: Attendance is mandatory as per the academic regulations.

LAB RECORD's: The student must:

1. Write the work sheets for the allotted experiment and keep them ready before the beginning of eachlab.
2. Keep all work in preparation of and obtained during lab.
3. Perform the experiment and record the observations in the worksheets.
4. Analyze the resultsand get the work sheets evaluated by the Faculty.
5. Upload the evaluated reports online from CMS LOGIN within the stipulated time.

Grading Policy:

The final grade of this course is awarded using the criterion detailed in the academic regulations. A large portion of the student's grade is determined in the comprehensive final exam of the Laboratory course (SEE PRACTICALS),resulting in a requirement of understanding the concepts and procedure of each lab experiment for successful completion of the lab course.

Pre-Requistes and Co-Requisties:

The lab course is to be taken during the same semester as AEEB15, but receives a separate grade. Students are required to have completed AHSB04,AHSB11 and AEE002 with minimum passing grade or better grade in each.

Course Goals and Objectives

This course examines the construction, operation, performance characteristics and application of electromechanical energy conversion devices such as DC generators and motors. It also gives an in-depth knowledge on the operation of speed control techniques of DC motors which are widely used in real time applications .In addition, the student should learn how to record experimental results effectively and present these results in a written report. More explicitly, the class objectives are:

1.The elementary experimental and modelling skills for handling problems with electrical machines in the industries and domestic applications.

2.The operation of DC Machines and its role in power transmission and distribution:
3. Analyse the performance leading to design of electric machines by conducting various tests and calculate the performance parameters

Use of Laboratory Instruments

One of the major goals of this lab is to familiarize the student with the proper equipment and techniques for making DC machines operation. Some understanding of the lab instruments is necessary to avoid personal or equipment damage. By understanding the device's purpose and following a few simple rules, costly mistakes can be avoided..

The following rules provide a guideline for instrument protection.

Instrument Protection Rules

1. Set instrument scales to the highest range before turning on the power/source.

2. Be sure instrument grounds are connected properly. Avoid accidental grounding of "hot" leads, i.e., those that are above ground potential.

3. Check polarity markings and connections of instruments carefully before connecting power.

4. Never connect an ammeter across a voltage source. Only connect ammeters in series with loads.

5. Do not exceed the voltage and current ratings of instruments or other circuit elements. This particularly applies to wattmeters since the current or voltage rating may be exceeded with the needle still on the scale.

6. Be sure the fuse and circuit breakers are of suitable value. When connecting electrical elements to make up a network in the laboratory, it is easy to lose track of various points in the network and accidentally connect a wire to the wrong place. A procedure to follow that helps to avoid this is to connect the main series part of the network first, then go back and add the elements in parallel. As an element is added, place a small check by it on your circuit diagram. Then go back and verify all connections before turning on the power. One day someone's life may depend upon your making sure that all has been done correctly.

Data Recording and Reports

The Laboratory Worksheets

Students must record their experimental values in the provided tables in this laboratory manual and reproduce them in the lab worksheets. Worksheets are integral to recording the methodology and results of an experiment. In engineering practice, the laboratory notebook serves as an invaluable reference to the technique used in the lab and is essential when trying to duplicate a result or write a report. Therefore, it is important to learn to keep accurate data. Make plots of data and sketches when these are appropriate in the recording and analysis of observations. Note that the data collected will be an accurate and permanent record of the data obtained during the experiment and the analysis of the results. You will need this record when you are ready to prepare a lab report i.e worksheets.

The Laboratory Files/Reports

Worksheets are the primary means of communicating your experience and conclusions to other professionals. In this course you will use the lab worksheets to inform your faculty coordinator about what you did and what you have learned from the experience. Engineering results are meaningless unless they can be communicated to others. You will be directed by your faculty coordinator to prepare a lab report on a few selected lab experiments during the semester.

Your laboratory report should be clear and concise. The lab report shall be student hand written on a work sheets provided by the college. As a guide, use the format on the next page. Use tables, diagrams, sketches, and plots, as necessary to show what you did, what was observed, and what conclusions you can draw from this by using pencil and scale. Free hand diagrams and tables will reduce your marks. Even though you will work with one or more lab partners, your report will be the result of your individual effort in order to provide you with practice in technical communication.

LAB-1 ORIENTATION

1.1 Introduction

In the first lab period, the students should become familiar with the location of equipment and components in the lab, the course requirements, and the teaching instructor. Students should also make sure that they have all of the co-requisites and pre-requisites for the course at this time.

1.2 Objective

To familiarize the students with the lab facilities, equipment, standard operating procedures, lab safety, and the course requirements.

1.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

1.4 Equipment needed

AEEB13 lab manual

1.5 Procedure

1. During the first laboratory period, the instructor will provide the students with a general idea of what is expected from them in this course. Each student will receive a copy of the syllabus, stating the instructor's contact information. In addition, the instructor will review the safety concepts of the course.
2. During this period, the instructor will briefly review the equipment which will be used throughout the semester. The location of instruments, equipment, and components (e.g., Ammeters, voltmeter, watt meter, AC machines and connecting wiring) will be indicated. The guidelines for instrument use will be reviewed.

PROBING FURTHER EXPERIMENTS: - Questions pertaining to this lab must be answered at the end of laboratory report.

LAB-2 MAGNETIZATION CHARACTERISTIC OF DC SHUNT GENERATOR

2.1 Introduction

The open circuit characteristics for a DC generator are determined as follows. The field winding of the DC generator (series or shunt) is disconnected from the machine and is separately excited from an external DC source. The generator is run at fixed speed (i.e. rated speed).

2.2 Objective

By the end of this lab, the student should learn the no load magnetization characteristics, the external characteristics of DC shunt generators.

2.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

2.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom
3. HMRL Adjustable Load Cart
4. A bench mounted Motor-Generator s
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

2.5 Background

A DC generator, whose schematic is an electrical machine which converts the mechanical energy of a prime mover (e.g. DC motor, AC induction motor or a turbine) into direct electrical energy. The generator shown in figure 1 is self exciting. It uses the voltage Ea generated by the machine to establish the field current If , which in turn gives rise to the magnetic-field flux. When the armature winding rotates in this magnetic field so as to cut the flux, the voltage Ea is induced in the armature. This voltage is commonly referred to as the armature electromotive force or EMF. The induced EMF is proportional to the rate of cutting the flux and is given by.

The magnetic field necessary for generator action may be provided by (a) permanent magnets, (b) electromagnets receiving their exciting current from an external source, and (c) electromagnets being excited from the current obtained from the generator itself (like that shown in figure 1). The use of permanent magnets is confined to very small generators. The electromagnetic excitations listed in (b) and (c) above give rise to generators having somewhat different types of characteristics. In the case of a compound generator, the series and shunt fields may be connected so as to aid each other, i.e. the fluxes set up by each will add up. An increase in the total flux will generate a greater EMF. Such a connection is known as cumulative. If, however, the shunt and series winding are so connected that the flux set up by one opposes the other, then the induced EMF will be smaller. This type of connection is called differential

2.6 Procedure

Magnetization Characteristics 1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.

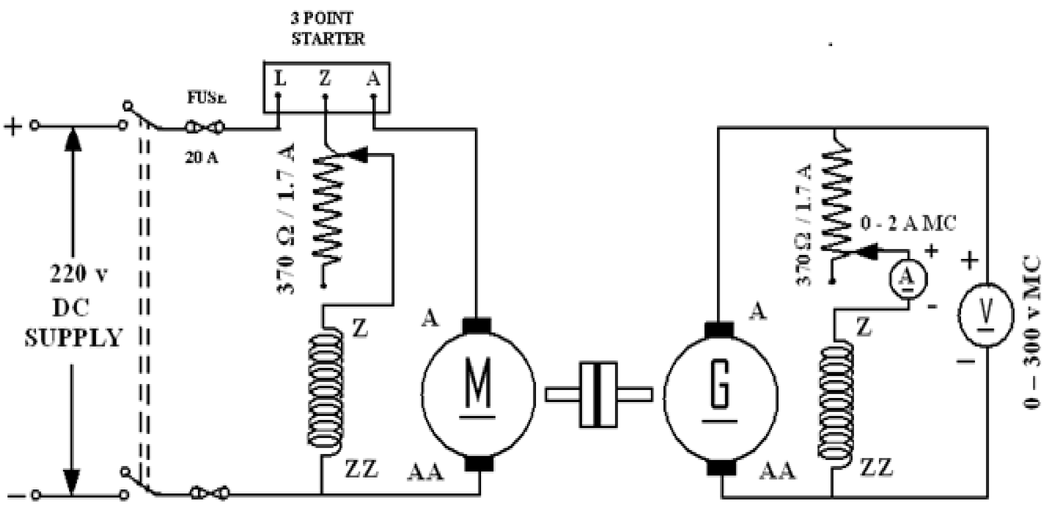

Figure 2.1 MAGNETIZATION CHARACTERISTIC

2. Keep the motor field rheostat (Rf) in the minimum resistance position.
3. Keep the generator field rheostat (Rf) in the maximum resistance position.
4.Observe the speed of the generator using a tachometer and adjust to the rated value by varying the motor field rheostat. Keep the same speed throughout the experiment 5.Note down the terminal voltage of the generator. This is the e.m.f. due to residual magnetism 6.Increase the generator field current If (ammeter) by gradually moving the rheostat for every value and note down the corresponding voltmeter reading. Increase the field current till induced e.m.f is about 120 percentage of rated value

S No	Field Current (Amp)	Generated Voltage (Volts)
1		
2		
3		
4		
5		

Table 2.1 Mgnetization Measured Values

2.7 Model graphs

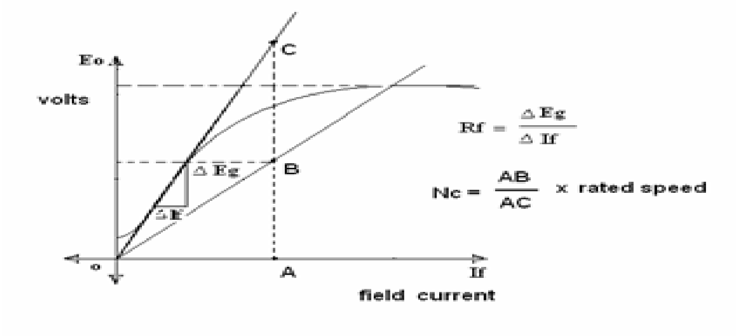

Figure 2.3: Field Current versus induced emf

2.8 Probing Further Experiments

Q1. Design the magnetizing characteristics of DC shunt generator by using the MAT Lab and Lab View and also find the critical resistance, critical speed.

Q2. Design the process of voltage build up in self excited DC generators and state the conditions for self excitation

LAB-3 LOAD TEST ON DC SHUNT GENERATOR

3.1 Introduction

To conduct load test on DC shunt generator and to draw the external and internal characteristics of DC shunt generator. It is a curve showing the variation in terminal voltage of the generator as the load on the generator is increased. At no load, the terminal voltage of the generator is at its rated value.

3.2 Objective

To determine the external and internal characteristic of a DC shunt generator

3.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

3.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom
3. HMRL Adjustable Load Cart
4. A bench mounted Motor-Generator set.
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5).
6. Connecting Wires.

3.5 Background

In a DC shunt generator, on no-load the terminal p.d. is equal to the no load induced e.m.f. E. When the armature delivers current, i.e. the generator is loaded: a) the induced e.m.f. decreases because the armature reaction reduces the flux per pole. b) V becomes less than E because of the voltage drop IaRa, where Ra is the total resistance of the armature circuit. The graph of induced e.m.f. against armature current is the internal characteristic , and the graph of terminal voltage against load current is the external characteristic, or voltage characteristic .We see both the characteristic drop from no load point, N, the second more than the first, as shown. When the load current Il progressively increased (by reducing the load resistance), at first the tendency of decreased resistance to increase the current is greater than the tendency of the armature reaction and the voltage drop to reduced terminal potential Difference and therefore, the current. Eventually a point will be reached at which these two effects neutralize each other. Beyond that second tendency will be predominate and the characteristic will turn back as shown.

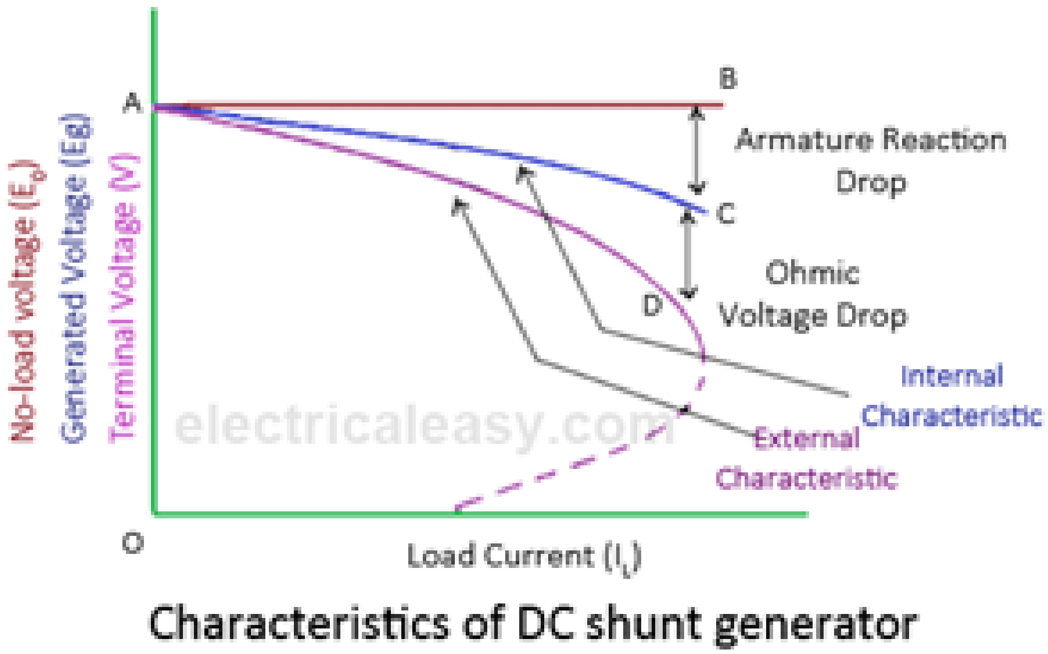

Figure 3.1 characteristics of DC Generator

3.6 Procedure

load test on DC shunt generator 1. 1. Make the connections as shown in the circuit diagram. Keep the motor field rheostat in the minimum position and the generator field rheostat in the maximum position at starting .

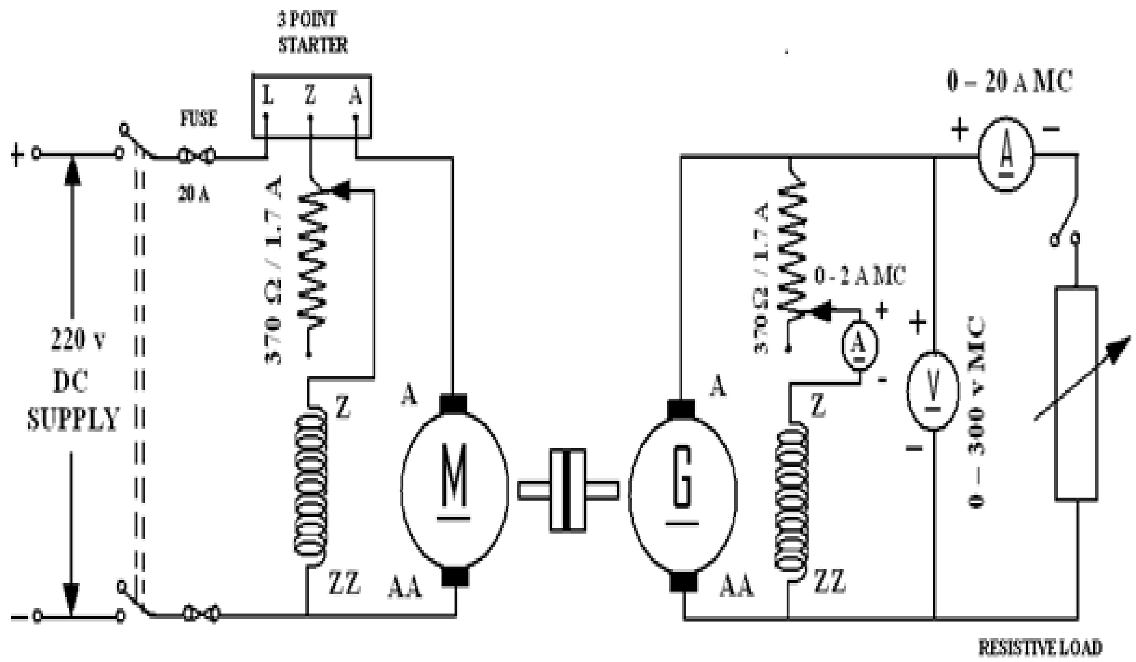

Figure 3.2 LOAD TEST ON DC SHUNT GENERATOR

2. Start the MG set and bring it to the rated speed of the generator by adjusting the motor field rheostat.
3. Adjust the terminal voltage to rated value by means of the generator field rheostat. Keep the rheostat in this position throughout the experiment as its variation changes the field circuit resistance and hence the generated emf.
4. Put on the load and note the values of the load current, IL; terminal voltage, V and field current, If at different values of the load until full load current is obtained.
5. Calculate the armature current in each case: Ia = IL + If.
6. The reflected current in the primaries flows as the circulating current in the closed loop formed by two primaries. This reflected current does not flow from the supply. It is to be noted that the net power drawn from the supply is only power corresponding to no load losses.
7.Measure the armature resistance by volt ampere method. Note down the voltage drop Va across the armature for different values of current I passing through it. Armature resistance in each case is calculated. Ra = Va / I., Ra (Hot) = 1.25 Ra. Take the mean of the values which are close together as the resistance of the armature, Ra
8.Calculate the generated e.m.f. E at each value of the load current. E= V+ Ia Ra
9.Draw external characteristic, VT versus IL and internal characteristic, E versus IL 10.Tabulate meter readings and calculate the circuit parameters.

S.No	I_L(Amp)	I_F(Amp)	I_a(Amp)	V_T(Volt)	E(Volt)
1					
2					
3					
4					
5					
6					

Table 3.1 Measured Values

3.7 Model graphs

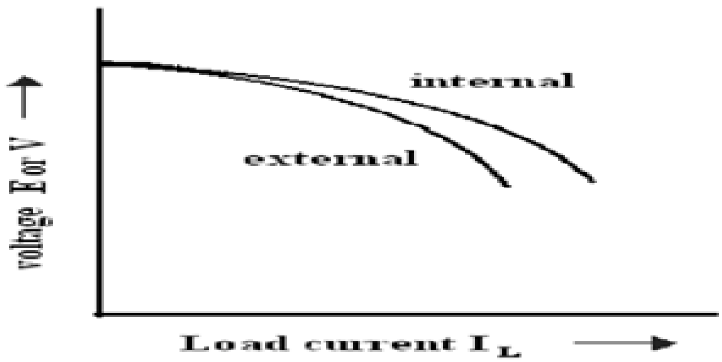

Figure 3.3: Internal and External Characteristics of DC Shunt Generator

3.8 Probing Further Experiments

Q1. Design load test on DC shunt generator using digital simulation.
Q2. Design load test on DC shunt generator using LabVIEW.

LAB-4 LOAD TEST ON DC SERIES GENERATOR

4.1 Introduction

To conduct load test on DC Series generator and to draw the external and internal characteristics of DC series generator. It is a curve showing the variation in terminal voltage of the generator as the load on the generator is increased. At no load, the terminal voltage of the generator is at its rated value.

4.2 Objective

To determine the external and internal characteristic of a DC series generator

4.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

4.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom
3. HMRL Adjustable Load Cart
4. A bench mounted Motor-Generator set.
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5).
6. Connecting Wires.

4.5 Background

In this Generator, because field windings are in series with the armature, they carry full armature current Ia as Ia is increased, flux and hence generated emf is also increased. The extra exciting current necessary to neutralize the wreaking effect of armature reaction at full load is given by the horizontal distance. It will be noticed that a series generator has rising voltage characteristics. The armature current, field current in a D.C series generator are equal. The series field current is zero and the generator voltage is due to residual flux and residual voltage is very low. However if the generator terminals are closed through a load resistance, the armature current will flow which improves residual flux and thus residual voltage. Simultaneously there is armature reaction, which causes, demagnetization which results in decrease of terminal voltage. This terminal voltage increases the field current. Finally flux gets saturated thus increase in load current. It causes decrease in terminal voltage due to increase in armature reaction and voltage drops due to armature and series field and finally goes terminal voltage to zero. he internal characteristic is the relation between induced e.m.f. and armature current. Similarly external characteristic is the relation between terminal voltage and load current.

4.6 Procedure

load test on DC series generator 1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram .

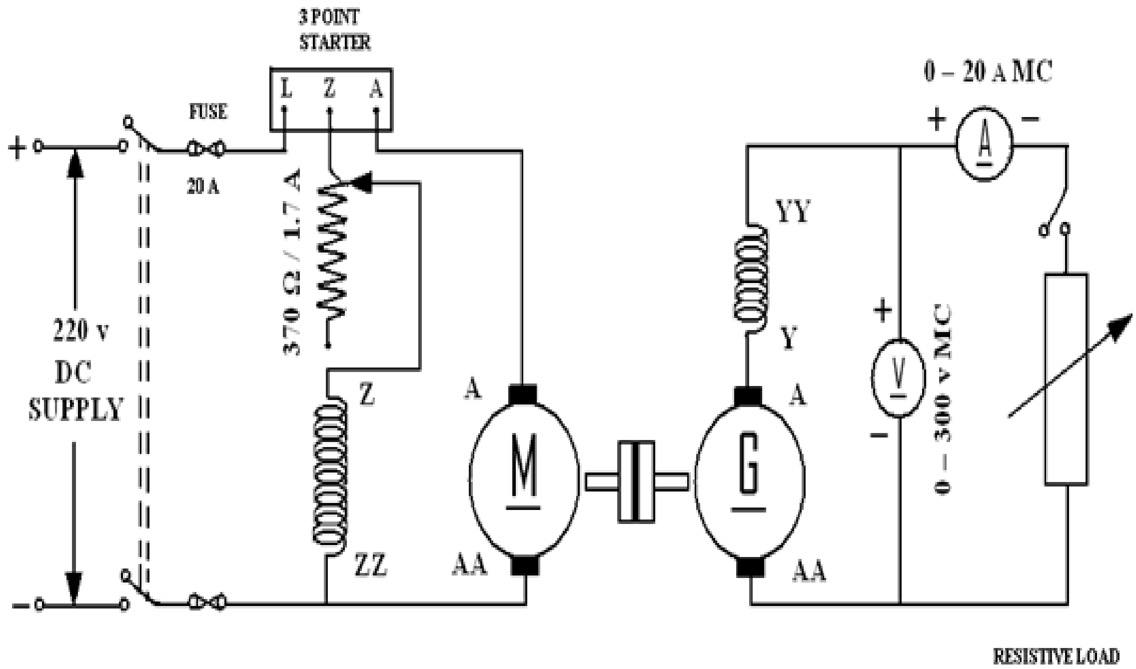

Figure 3.1 LOAD TEST ON DC SERIES GENERATOR

2.Keeping the motor field resistance minimum and the generator output terminals are open circuited, give supply and start the motor - generator set.
3. Adjust the speed of the MG Set to the rated speed of the generator using the motor field rheostat (Rf).
4. Note down the voltage due to residual magnetism on no load
5.Run the DC series generator under rated load conditions and note down the terminal voltage and load current by removing the loads slowly. (but not no-load condition).
6. Measure the generator armature resistance Ra by drop metho.
7.Calculate the generated emf E at each load from the relation, Eg = V+ I(Ra + RSe).
8.Draw the external characteristic, VT vs. IL and the internal characteristic, Eg Vs Ia on the same graph sheet.
9.Tabulate meter readings and calculate the circuit parameters.

S. NO.	I_L(Amp)	V_T(Volt)	$E_g = V_T + I_L(R_a + R_S)$
1			
2			
3			
4			
5			

Table 3.1 Measured Values

4.7 Model graphs

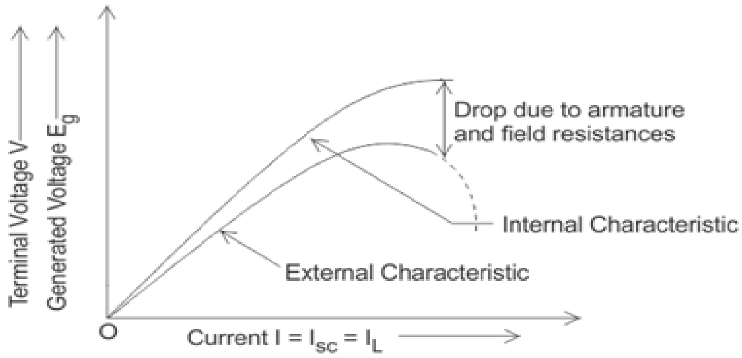

Figure 3.3: Internal and External Characteristics of DC series Generator

4.8 Probing Further Experiments

Q1. Design load test on DC series generator using digital simulation.
Q2. Design load test on DC series generator using LabVIEW.

LAB-5 LOAD TEST ON DC COMPOUND GENERATOR

5.1 Introduction

To conduct load test on DC Compound generator and to draw the external and internal characteristics of DC compound generator. It is a curve showing the variation in terminal voltage of the generator as the load on the generator is increased. At no load, the terminal voltage of the generator is at its rated value.

5.2 Objective

To determine the external and internal characteristic of a DC compound generator

5.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

5.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom
3. HMRL Adjustable Load Cart
4. A bench mounted Motor-Generator set.
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5).
6. Connecting Wires.

5.5 Background

D.C compound generator consists of both series and shunt field windings. The effect of series field is variable, however since its ampere turns depend upto the load current. Shunt and series field coils should be so connected that they create the flux in the same direction. This type of connection of the generator is known as differential compound connection. If the full load voltage is-load voltage, it is referred as flat compound.

5.6 Procedure

load test on DC COMPOUND generator 1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram .

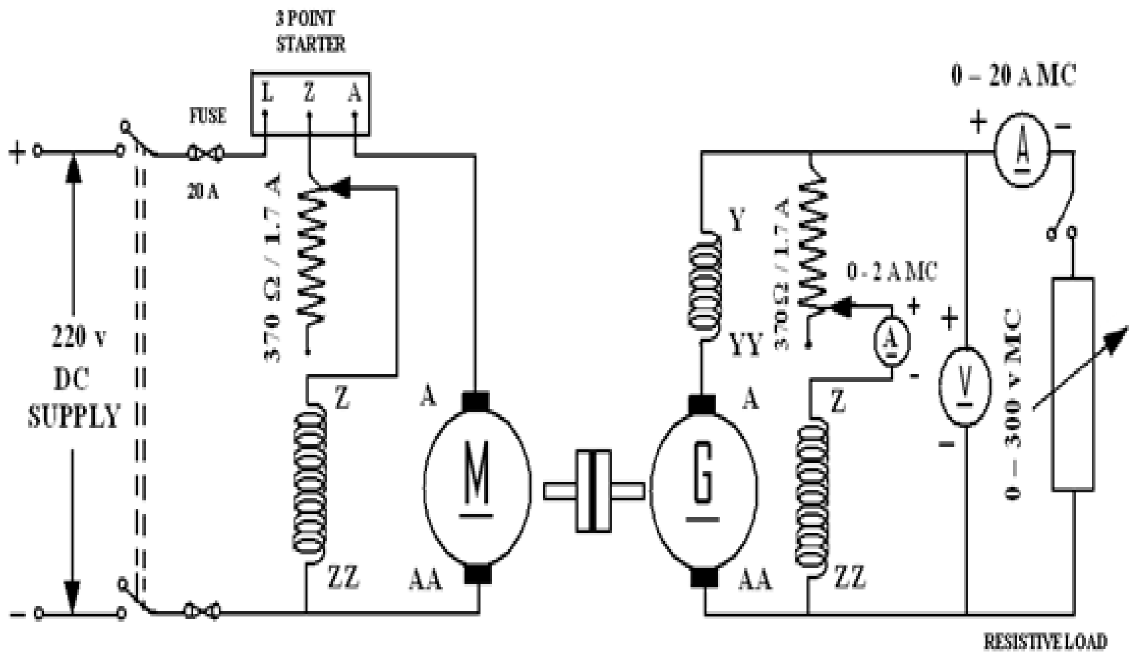

Figure 3.1 LOAD TEST ON DCCOMPOUND GENERATOR

2. Keep the motor field rheostat in minimum resistance position (Resistance) and the generator field rheostat in maximum resistance position at starting.
3. Start the MG set and bring it to the rated speed of the generator by adjusting the motor field rheostat.
4.Adjust the terminal voltage of the generator to rated value by means of the generator field rheostat. Keep the rheostat in this position throughout the experiment as its variation changes the field circuit current and hence the generated EMF
5.Put on the load and note down the values of load current IL and terminal voltage VT at the generator side, for different values of load until full load current).
6. Draw external characteristics VT and IL and Internal characteristics Eg and I Where Eg = V+ IaRa
7.Calculate the generated emf E at each load from the relation, Eg = V+ IRa
8.Tabulate meter readings and calculate the circuit parameters.

S.NO.	I_L(Amp)	V_T(Volt)	$Eg = V + I_aR_a$
1			
2			
3			
4			
5			

Table 3.1 Measured Values

5.7 Model graphs

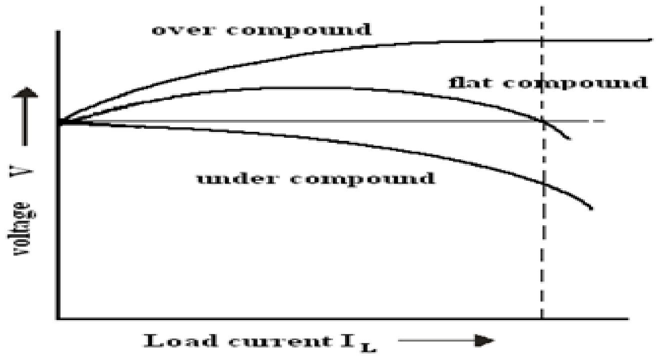

Figure 3.3: Internal and External Characteristics of DC compound Generator

5.8 Probing Further Experiments

Q1. Design load test on DC compound generator using digital simulation.
Q2. A 4 pole DC shunt generator with wave connected armature has 41 slots and 12 conductors per slot. Ra = 0.5 ohms, Rsh = 200ohms and flux per pole is 125Wb. When the generator is driven at a speed of 1000 rpm, calculate the voltage across 10 ohms load resistance connected across the armature terminals.

LAB-6 HOPKINSON'S TEST ON DC SHUNT MACHINES

6.1 Introduction

Hopkinson's Test is another useful method of testing the efficiency of a DC machine. It is a full load test and it requires two identical machines which are coupled to each other. One of these two machines is operated as a generator to supply the mechanical power to the motor and the other is operated as a motor to drive the generator. For this process of back to back driving the motor and the generator, Hopkinson's test is also called back-to-back test or regenerative test.

6.2 Objective

To perform Hopkinson's test on the given motor - generator set and determine the efficiency of both motor and generator.

6.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

6.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

6.5 Background

Two identical d.c. shunt machines are mechanically coupled and connected in parallel across the d.c. supply. By adjusting the field excitation of the machines, one is run as a motor and the other as a generator. The electric power from the generator and electrical power from the d.c. supply are fed to the motor. The electric power given to the motor is mostly converted into mechanical power, the rest going to the various motor losses. This mechanical power is given to the generator. The electrical power of the generator is given to the motor except that which is wasted as generator losses. Thus the electrical power taken from the d.c. supply is the sum of motor and generator losses and this can be measured directly by a voltmeter and an ammeter. Since the power input from the d.c. supply is equal to the power required to supply the losses of the two machines, this test can be carried out with a small amount of power. By adjusting the field strengths of the machines, any load can be put on the machines. Therefore, we can measure the total loss of the machines at any load. Since the machines can be tested under full-load conditions (of course at the expense of power equal to the losses in the two machines), the temperatures rise and commutation qualities of the machines can be observed. This is the working principle of Regenerative or Hopkinson's test.

6.6 Procedure

HOPKINSON'S TEST ON DC SHUNT MACHINES 1. Make the connections as per the circuit diagram. Keep the motor field rheostat at minimum and generator field rheostat at maximum resistance position and the switch K is in open position.

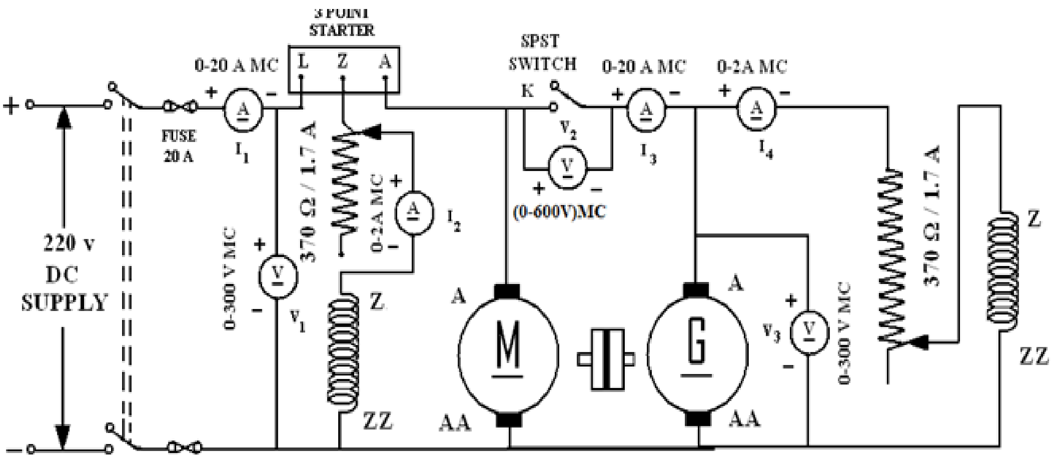

Fig – 5.1 Identical DC Shunt Machines

Figure 6.1 Identical DC Shunt Machines

2. Excite the generator by decreasing the generator field rheostat resistance until the voltmeter across the switch reads zero, then close the switch K.
3. Load the generator in steps by decreasing the field rheostat resistance of the generator or by increasing the field rheostat resistance of the motor.
4.Take the readings of all the meters for each load and measure the speed in each step.

S.No.	V_1(Volt)	I_1(Amp)	I_2(Amp)	I_3(Amp)	I_4(Amp)	N(rpm)
1						
2						
3						
4						
5						

Table 6.1 Hopkinsons Test Measured Values

6.7 Calculations

Hopkinsons Test

I_1 = line current of motor ; I_2 = exciting current of motor

I_3 = load current of generator. ; I_4 = exciting current generator

Armature cu loss in generator $W_{ag} = (I_3 + I_4)^2 R_{ag}$

Armature cu loss in motor $W_{am} = (I_1 + I_3 - I_2)^2 R_{am}$

Shunt cu loss in generator $W_{fg} = VI_4$, Shunt cu loss in motor $W_{fm} = VI_2$

Total power drawn from supply = VI_1 = Total cu loss and Stray losses

Total stray loss for the set $W_s = VI_1 - [W_{ag} + W_{am} + W_{fg} + W_{fm}]$

Stray losses of each machine = $W_s / 2$

Efficiency of motor:

Motor input Power = $V(I_1 + I_3)$

Armature Cu loss in motor = $(I_1 + I_3 - I_2)^2 R_a$

Output power = input power to Motor – (motor armature copper loss + Motor shunt field loss + Stray loss)

$= V(I_1 + I_3) - [(I_1 + I_3 - I_2)^2 R_{am} + VI_2 + W_s / 2]$

$$\% \text{ Efficiency} = \frac{\text{Output power}}{\text{Input power}} \times 100$$

Efficiency of Generator:

Generator output power = VI_3

Input Power = (Output power + Generator Armature copper loss + Generator Shunt field loss + stray loss)

$= VI_3 + (I_3 + I_4)^2 R_{ag} + VI_4 + W_s / 2$

$$\% \text{ Efficiency} = \frac{\text{Output power}}{\text{Input power}} \times 100$$

6.8 Tabular column

PART - I: Calculated Values for Motor

S.No	Input Current $(I_1 + I_3 - I_2)$	Armature Cu loss $(I_1 + I_3 - I_2)^2 R_{am}$	Field cu Loss VI_2	Stray loss $W_s / 2$	Output Power	Input power	% Efficiency
1							
2							
3							
4							
5							

Table 6.2 Calculated values

PART - II: Calculated Values for Generator

S.No	output Current I_3	Armature Cu loss $(I_3 + I_4)^2 R_{ag}$	Field cu Loss VI_4	Stray loss $W_s / 2$	Input Power	Output power	% Efficiency
1							
2							
3							
4							
5							

Table 6.3 Calculated valuess

6.9 Model graphs

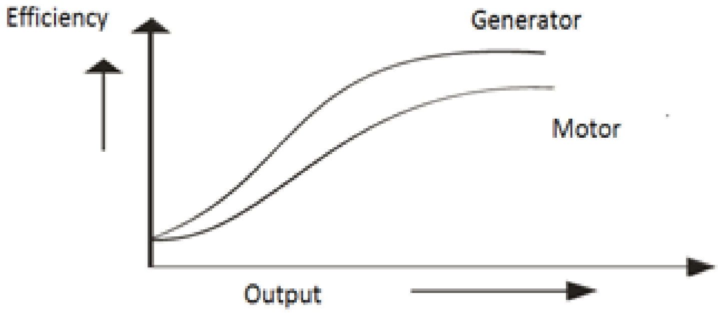

Figure 6.2:output versus efficiency

6.10 Probing Further Experiments

Q1.Design HOPKINSON'S TEST ON DC SHUNT MACHINES the using digital simulations.

Q2. Describe the Hopkinson's test for obtaining the efficiency of two similar shunt motors. The readings obtained in such a test were as follows ; line voltage 100 V motor current 30 A generator current 25 A armature resistance of each machine 0.25 W. Calculate the efficiency of each machine from these results, ignoring the field currents and assuming that their iron and mechanical losses are the same

LAB-7 FIELD TEST ON DC SERIES MACHINES

7.1 Introduction

A field test uses two similar dc series motors, which are mainly used for electric traction works. In fields test, two similar dc series motors with their field windings connected in series are used to determine losses and efficiency. The two machines are coupled mechanically in which one runs as a motor and the other as a generator driven by the motor. The electrical output from the generator is passed through variable load resistance R and dissipated as heat.

7.2 Objective

To determine the efficiency of the two DC series machines by conducting field test.

7.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

7.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

7.5 Background

This test is applicable to two similar series motors. Series motors which are mainly used for traction work are easily available in pairs. The two machines are coupled mechanically. One machine runs normally as a motor and drives generator whose output is wasted in a variable load R (Fig. 7.1). Iron and friction losses of two machines are made equal (i) by joining the series field winding of the generator in the motor armature circuit so that both. machines are equally excited and (ii) by running them at equal speed. Load resistance R is varied till the motor current reaches its full-load value indicated by ammeter A1. After this adjustment for full-load current, different ammeter and voltmeter readings are noted

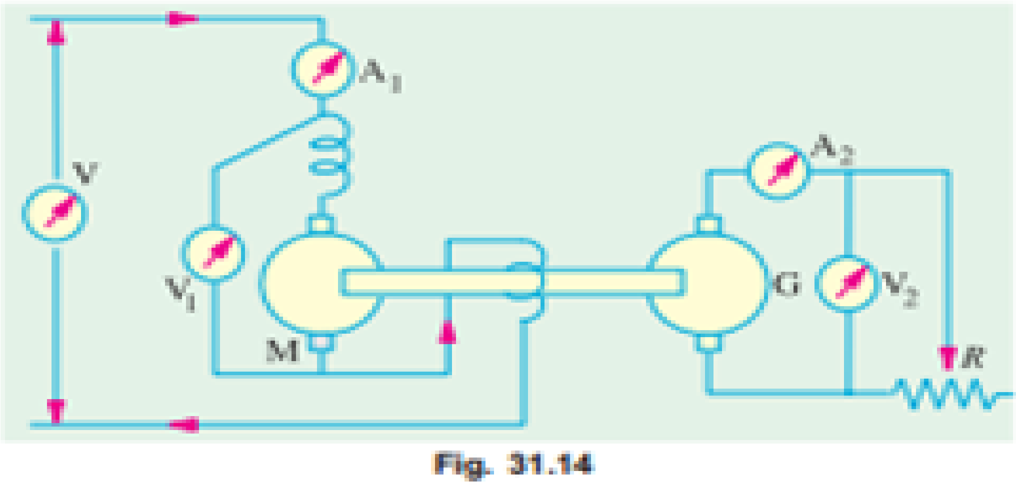

Figure 7.1 Identical DC Shunt Machines

7.6 Procedure

FIELD TEST ON DC SERIES MACHINES 1. Make the connections as per the circuit diagram. Keep the motor field rheostat at minimum and generator field rheostat at maximum resistance position and the switch K is in open position.

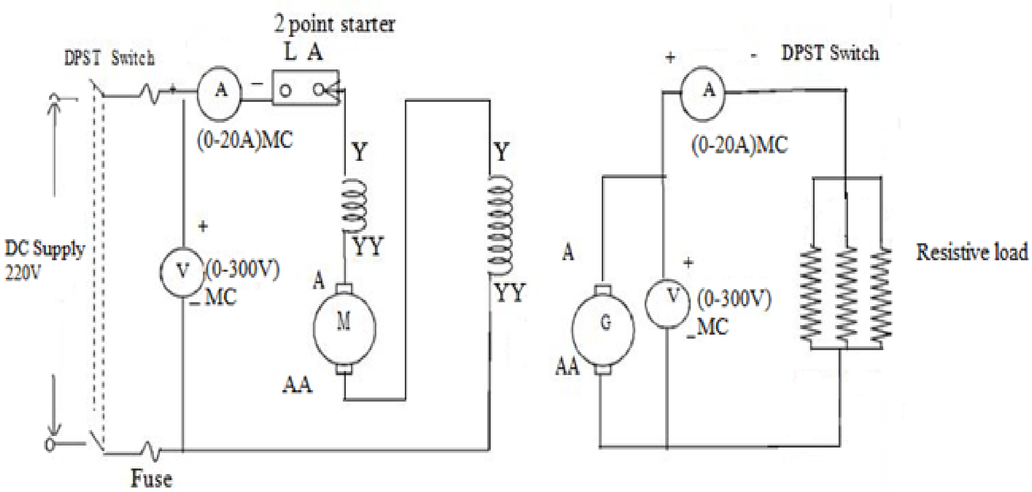

Figure 7.2 Identical DC Shunt Machines

2. Start the motor by moving the handle of the starter slowly.
3.Now keep the input DC voltage constant at 220V DC.
4.Now increase the load of the generator up to the rated value of armature current and note down the readings of ammeter, voltmeters connected in the circuit.
5.Reduce the loads one by one till the motor speed does not exceed 1800rpm 6.Note down the readings of the instruments at different loads. Armature resistance of the motor Ra1 Series field resistance of the motor Rse1 Armature resistance of the generator Ra2 Series field resistance of the generator Rse2 7.Gradually, reduce the armature voltage of the prime mover and then switch off the Supply

S.No	V_1(volts)	I_1 (Amps)	V_L (volts)	I_L (amps)	N (rpm)
1					
2					
3					
4					
5					

Table 7.1 Measured Values

7.7 Calculations

Field Test

Power input $P_{in}= V_1 I_1$

Power output $P_{out}= V_L I_L$

Total losses of the two machines $P_L= P_{in}-P_{out}$ Field copper losses in the motor= $I_1^2 R_{se1}$

Field copper losses in the generator= $I_1^2 R_{se2}$ Armature copper losses in the motor= $I_1^2 R_{a1}$

Armature copper losses in the generator= $I_L^2 R_{a2}$

Total copper losses in the field and armature of the motor and generator is P_{cu}

$P_{cu}= I_1^2 R_{se1}+ I_1^2 R_{se2}+ I_1^2 R_{a1}+ I_L^2 R_{a2}$

Stray losses per each machine $W_s= (P_L-P_{cu})/2$

Motor efficiency calculations:

Power input to the motor $P_{in}=V_1 I_1$

Total losses in the motor $P_T=I_1^2 R_{se1}+I_1^2 R_{a1}+W_s$

Motor output $P_{out}=P_{in}- P_T$

%Efficiency $\eta= P_{out} / P_{in}{}^{*}100$

Generator efficiency calculations:

Generator output $P_{out}(g) = V_L I_L$

Total losses of the generator $W_{gt}= W_s+ I_L^2 R_{se2}+I_L^2 R_{a2}$

Power input to the generator $P_{in}= P_{out}(g) + W_{gt}$

% Efficiency of the generator $\eta= P_{out(g)} / P_{in}{}^{*}100$

7.8 Probing Further Experiments

Q1.Design Field test on identical DC Series machine the using digital simulations.

Q2. In a Field's test on two 230-V, 1.492 kW mechanically-coupled similar series motors, the following figures were obtained. Each has armature and compile winding resistance of 2.4 W, series field resistance of 1.45 W and total brush drop of 2 V. The potential difference. across armature and field was 230 V with a motor current of 10.1 A. The generator supplied a current of 8.9 A at a terminal potential difference. of 161 V. Calculate the efficiency and output of the motor for this load?

LAB-8 SPEED CONTROL OF DC SHUNT MOTOR AND SWINBURNE'S TEST ON DC SHUNT MOTOR

8.1 Introduction

Often we want to control the speed of a DC motor on demand. This intentional change of drive speed is known as speed control of a DC motor. Speed control of a DC motor is either done manually by the operator or by means of an automatic control device. This is different to speed regulation – where the speed is trying to be maintained (or 'regulated') against the natural change in speed due to a change in the load on the shaft.

8.2 Objective

To vary the speed of the given DC shunt motor by armature control and field control methods

8.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual.

8.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

8.5 Background

Terminal voltage and external resistance involve a change that affects the armature circuit, while flux involves a change in the magnetic field. Therefore speed control of DC motor can be classified into: 1. Armature Control Methods 2. Field Control Methods We will discuss how both of these methods control the speed of DC series motors and DC shunt motors. Speed Control of DC Series Motor Speed control methods for a DC series motor can be classified as: 1. Armature Control Methods 2. Field Control Methods Armature Controlled DC Series Motor Speed adjustment of a DC series motor by armature control may be done by: 1. Armature Resistance Control Method 2. Shunted Armature Control Method 3. Armature Terminal Voltage Control

8.6 Procedure

SPEED CONTROL Armature Control Method: (below rated speed) 1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.

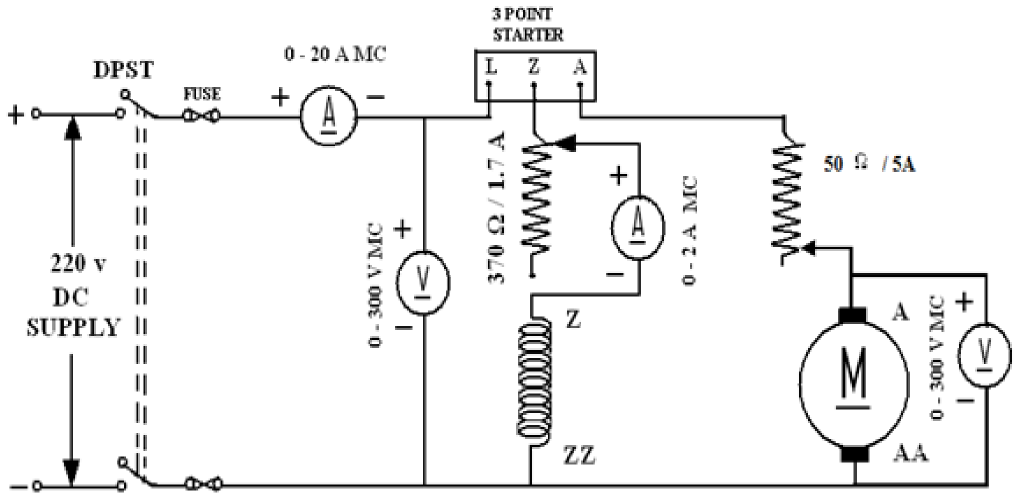

Figure 6.1 Speed control of DC motor

2.Keep the motor field rheostat (Rf) in the minimum position and the armature rheostat (Ras) in the maximum position, start the MG set.
3. Give supply and accelerate the motor using 3-point starter.
4.Decrease the armature rheostat value and note down speed and induced emf in motor winding.
5.Tabulate these readings and plot the graph Eb VS N

S.No.	E_b(Volt)	Speed (rmp)
1		
2		
3		
4		
5		
6		

Table 8.1 below rated Measured Values

Field Control Method: (above rated speed) 1.Maintain the armature rheostat in maximum position and vary the field current (If) by varying the field rheostat. Note down the speeds (N) at different values of field current. Take care that the speed doesn't exceed 2000 rpm. Note down the armature voltage also.

2.Tabulate these readings and plot the N Vs If describes the field control of motor speed on no load. .

S. No.	E_b(Volt)	Speed (rmp)
1		
2		
3		
4		
5		
6		

Table 8.1 Above rated Measured Values

8.7 Model graphs

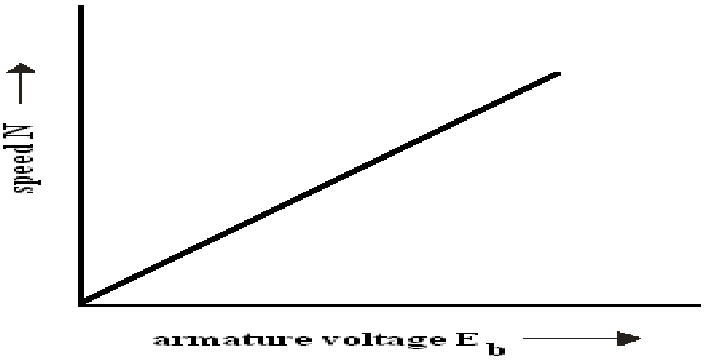

Figure 8.2:Armature Control

8.8 Model graphs

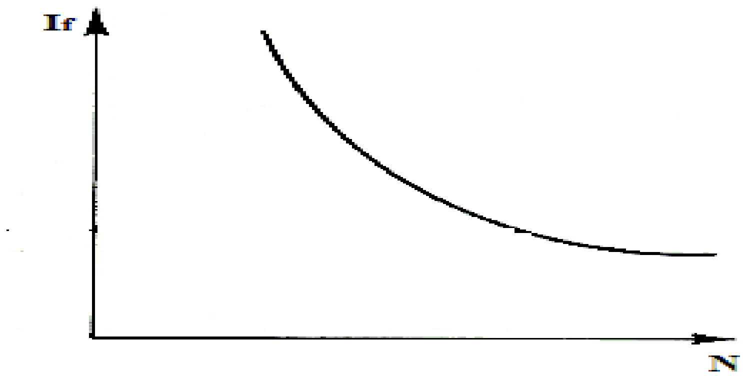

Figure 8.3:Field Control

8.9 Probing Further Experiments

Q1.Design of speed control of DC Shunt motor the using digital simulations.

Q2.Simulation and construction of a speed control for a DC series motor

LAB-9 BRAKE TEST ON DC COMPOUND MOTOR

9.1 Introduction

Brake Test on D.C. Compound Motor and to draw its performance curves. Consists of applying a brake to a water - cooled pulley mounted on the motor shaft. The net pull on the band due to friction at the pulley is (S1 - S2) Kg Wt. Shaft torque T sh = 9.81

9.2 Objective

To determine the efficiency of DC compound motor by conducting brake test.

9.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

9.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

9.5 Background

Another method of testing a dc motor is brake test method. This is direct method of testing the motor. In this method the motor is putting on the direct load by means of a belt and water cooled pulley arrangement. By adjusting the tension of belt. The load is adjust the various values of currents. The load is finally adjusted to get full load current the power development gets wasted against the friction b/w belt and shaft. due to the braking action of belt the test is called brake test. In the brake test compound motor we are mainly used in long shunt compound motor .In this type the shunt field winding is connected across the combination of armature and series of field winding. The resistance of field winding in series "Rse" and shunt field winding "Rsh". The total current drawn from supply is "Il I L=Ise+Ish, Ise=Ia Long shunt compound motor is compared to shunt mot so the torque Produce in the motor is torque direct propotional to Ia.

9.6 Procedure

BRAKE TEST ON DC COMPOUND MOTOR

1. Make the connections as shown in the circuit diagram.

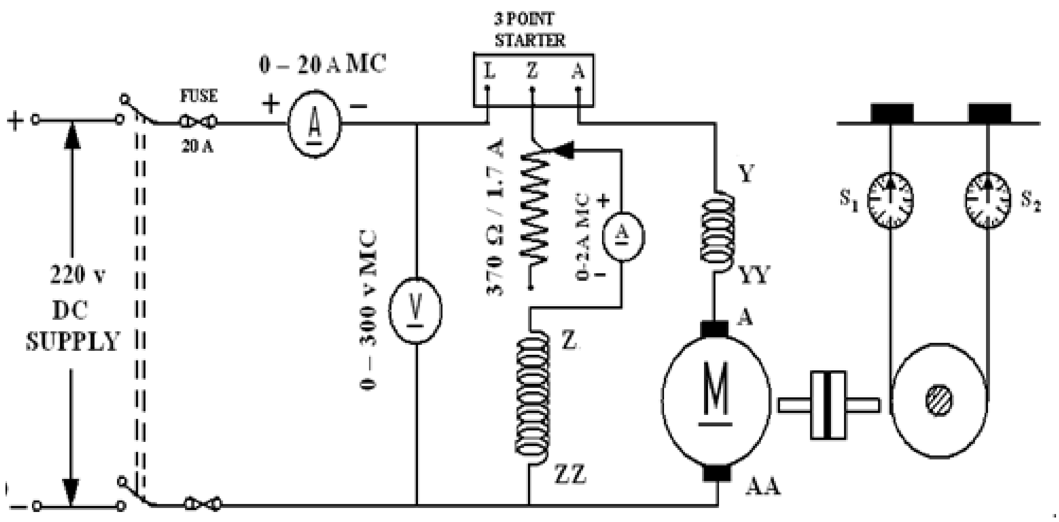

Figure 7.2 Brake test on DC compound motor

2. Keeping the field rheostat (Rf) at the minimum position, switch on the supply and start the motor.
3.Adjust the speed of the motor on no load to its rated value by means of the field rheostat. Do not disturb the position of the rheostat throughout the test.
4.Put on the load by tightening the screws of the spring balances. Note down the spring tensions, the speed, the voltage and the currents at different loads until full load current is obtained.
5.Reduce the loads one by one till the motor speed does not exceed 1800rpm 6.Note down the readings of the instruments at different loads. Armature resistance of the motor Ra1 Series field resistance of the motor Rse1 Armature resistance of the generator Ra2 Series field resistance of the generator Rse2 7.Gradually, reduce the armature voltage of the prime mover and then switch off the Supply

S No	I_L (A)	V_L (V)	W_1 Kg	W_2 Kg	W (kg) = $W_1 - W_2$	N (RPM)	T = rgW (N-m)	P_0= $2\Pi NT/60$	P_I= $V_L I_L$	η = P_0/P_Ix 100
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Table 9.1 Measured Values

8. The load on the drum is removed and the motor is stopped. 9. The efficiency is calculated at different load conditions

9.7 Calculations

Brake Test on DC Compound Motor 1. Measure the circumference of the brake drum and calculate its radius (r), in meters.
2. Calculate the torque, T = Wrg (N-m). Where W = W1 − W2 = spring balance reading (the difference between the spring tensions) and 'g' is acceleration due to gravity i.e.9.81. Calculate the power output of the motor given by P0= 2UNT/60
3. Calculate the input power, PI =VIL (IL is the line current = Ia+ If).
4. Calculate the percentage efficiency, efficiency = P0/PIx 100
5. Draw the following graphs:
a) Output Vs efficiency, T, Ia and N in one graph.
b) Speed Vs Torque.

9.8 Model graphs

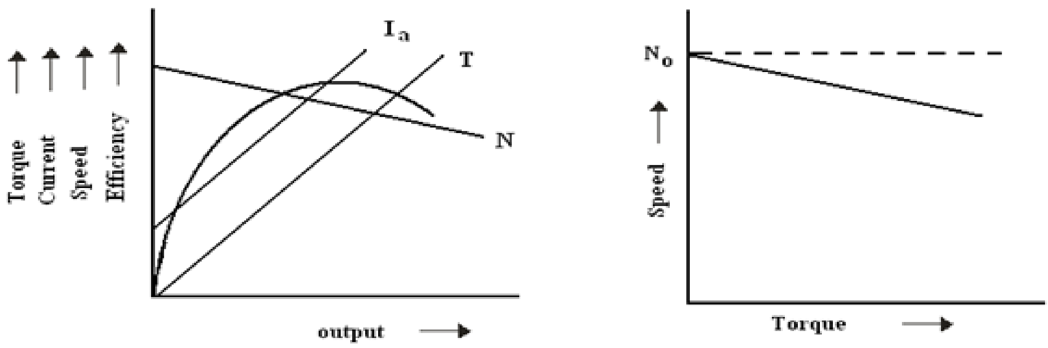

Figure 9.2:Performance Characteristics of DC compound Motor

9.9 Probing Further Experiments

Q1.Design the DC compound motor the using digital simulations.

Q2. Design the break test on DC compound motor by using labview to verify the different type of characteristics.

LAB-10 BRAKE TEST ON A DC SHUNT MOTOR

10.1 Introduction

The Brake test can be conducted by using a belt brake or rope brake. For a constant applied voltage, the field current is constant for a D.C. Shunt motor. The flux will, therefore have its maximum value at no-load, and because of armature reaction will decrease slightly as the load increases

10.2 Objective

To determine the efficiency of DC shunt motor by conducting brake test

10.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

10.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

10.5 Background

In this method, a brake is applied to a water-cooled pulley mounted on the motor shaft as shown in Fig.1. One end of the rope is fixed to the floor via a spring balance S and a known mass is suspended at the other end. If the spring balance reading is S kg-Wt and the suspended mass has a weight of W kg-Wt,then, Net pull on the rope = (W - S) kg-Wt = (W - S)9.81 newtons If r is the radius of the pulley in meters, then the shaft torque Tsh developed by the motor is Tsh = (W - S)9.81r N - m

10.6 Procedure

BRAKE TEST ON DC SHUNT MOTOR

1. Make the connections as shown in the circuit diagram.

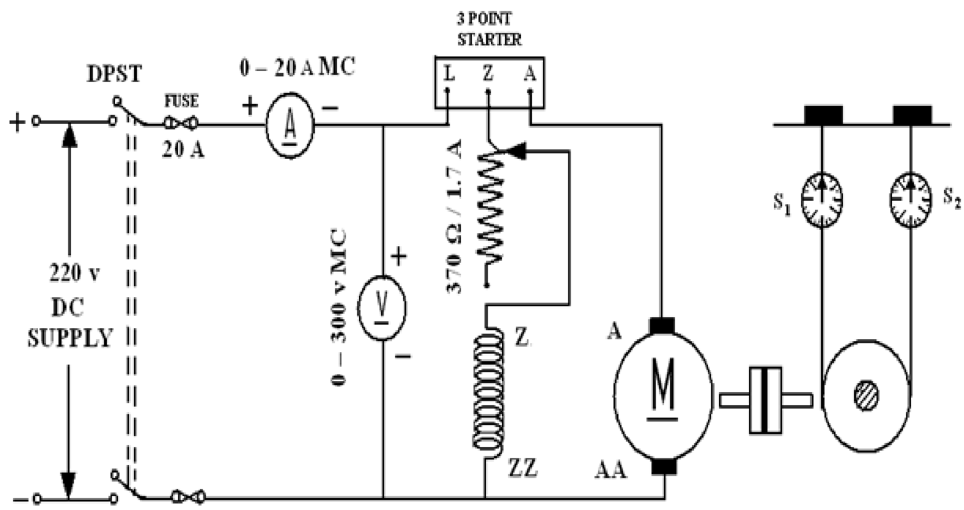

Figure 10.1 Brake test on DC shunt motor

2. Keeping the field rheostat (Rf) at the minimum position, switch on the supply and start the motor.
3.Adjust the speed of the motor on no load to its rated value by means of the field rheostat. Do not disturb the position of the rheostat throughout the test.
4.Put on the load by tightening the screws of the spring balances. Note down the spring tensions, the speed, the voltage and the currents at different loads until full load current is obtained.
5.Reduce the loads one by one till the motor speed does not exceed 1800rpm 6.Note down the readings of the instruments at different loads. Armature resistance of the motor Ra1 Series field resistance of the motor Rse1 Armature resistance of the generator Ra2 Series field resistance of the generator Rse2 7.Gradually, reduce the armature voltage of the prime mover and then switch off the Supply

S No	I_L (A)	V_L (V)	W_1 Kg	W_2 Kg	W (kg) = $W_1 - W_2$	N (RPM)	T = rgW (N-m)	P_0= $2\Pi NT/60$	P_I= $V_L I_L$	η = P_0/P_Ix 100
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

Table 9.1 Measured Values

8. The load on the drum is removed and the motor is stopped. 9. The efficiency is calculated at different load conditions

10.7 Calculations

Brake Test on DC Shunt Motor 1. Measure the circumference of the brake drum and calculate its radius (r), in meters.
2. Calculate the torque, T = Wrg (N-m). Where W = W1 − W2 = spring balance reading (the difference between the spring tensions) and 'g' is acceleration due to gravity i.e.9.81. Calculate the power output of the motor given by P0= 2UNT/60
3. Calculate the input power, PI =VIL (IL is the line current = Ia+ If).
4. Calculate the percentage efficiency, efficiency = P0/PIx 100
5. Draw the following graphs:
a) Output Vs efficiency, T, Ia and N in one graph.
b) Speed Vs Torque.

10.8 Model graphs

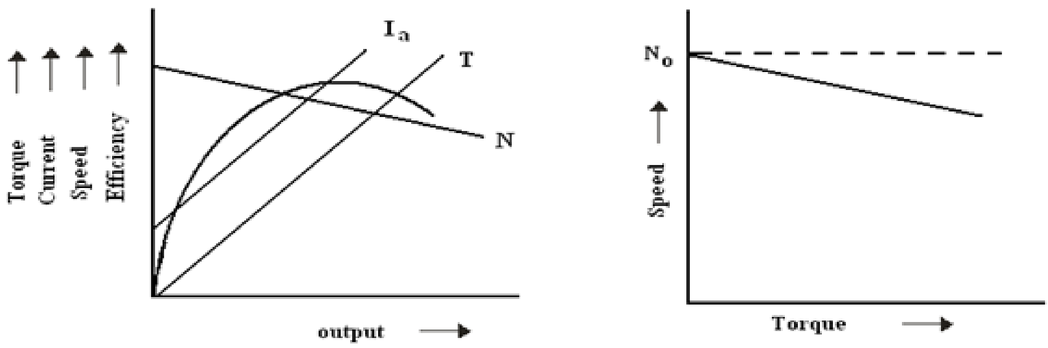

Figure 9.2:Performance Characteristics of DC Shunt Motor

10.9 Probing Further Experiments

Q1.Design the DC shunt motor the using digital simulations.

Q2. Design the break test on DC shunt motor by using labview to verify the different type of characteristics.

LAB-11 RETARDATION TEST

11.1 Introduction

In the retardation test, the dc machine is run as a motor at a speed just above the normal. Then the supply to the armature is cut off while the field is normally excited. ... From these observations, the rotational losses (i.e., friction, windage and iron losses) and hence the efficiency of the machine can be determined

11.2 Objective

To determine the stray losses and efficiency of DC shunt machine by conducting retardation test.

11.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

11.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

11.5 Background

In the retardation test, the d.c. machine is run as a motor at a speed just above the normal. Then the supply to the armature is cut off while the field is normally excited. The speed is allowed to fall to some value just below normal. The time taken for this fall of speed is noted. From these observations, the rotational losses (i.e., friction, windage and iron losses) and hence the efficiency of the machine can be determined

Let N = normal speed in r.p.m.

ω = normal angular velocity in rad/s = $2\pi N/60$

$\therefore$ Rotational losses, W = Rate of loss of K.E. of armature

or $$W = \frac{d}{dt}\left(\frac{1}{2}I\omega^2\right) = I\omega\frac{d\omega}{dt}$$

Here I is the moment of inertia of the armature. As $\omega = 2\pi N/60$,

$$\therefore \quad W = I \times \frac{2\pi N}{60} \times \frac{d}{dt}\left(\frac{2\pi N}{60}\right) = \left(\frac{2\pi}{60}\right)^2 IN\frac{dN}{dt}$$

or $$W = 0.011\ IN\frac{dN}{dt}$$

Let us illustrate the application of retardation test with a numerical example. Suppose the normal speed of a d.c. machine is 1000 r.p.m. When retardation test is performed, the time taken for the speed to fall from 1030 r.p.m. to 970 r.p.m. is 15 seconds with field normally excited. If the moment of inertia of the armature is 75 kg m , then,

$$\text{Rotational losses, } W = 0.011\ IN\frac{dN}{dt}$$

Here $I = 75\ \text{kgm}^2; \qquad N = 1000\ \text{r.p.m}$

$$dN = 1030 - 970 = 60\ \text{r.pm.}; \qquad dt = 15\ \text{sec}$$

$$\therefore \quad W = 0.011 \times 75 \times 1000 \times \frac{60}{15} = 3300\ \text{watts}$$

The main difficulty with this method is the accurate determination of the speed which is continuously changing.

11.6 Procedure

RETARDATION TEST

1. Make the connections as shown in the circuit diagram.

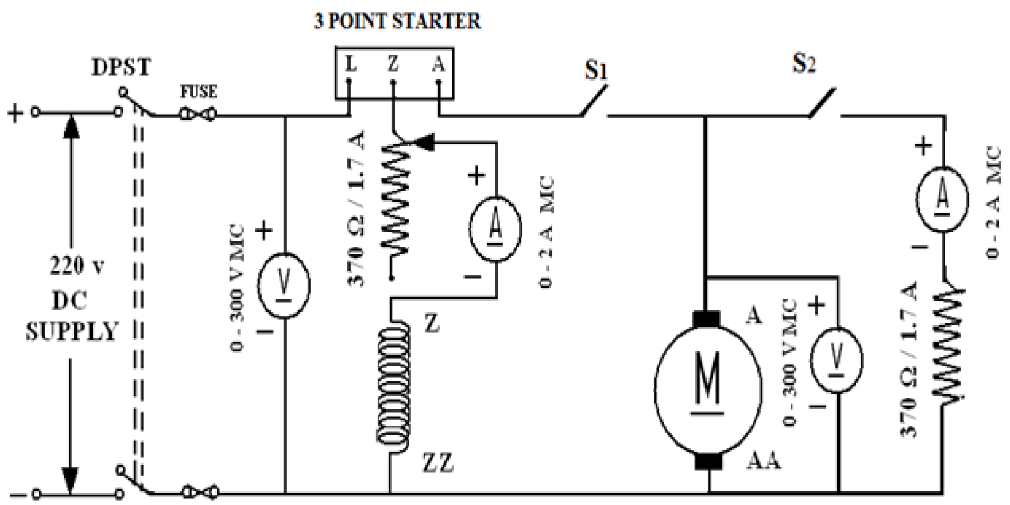

Figure 11.1 Retardation Testr

2. Initially the switch S2 is open and S1 is closed then the motor is started with the help of three point starter.
3.The speed is adjusted to just above the rated speed by adjusting the field rheostat..
4.The voltage is noted then switch S1 is opened and also note down the time taken to reach the armature voltage to a voltage of 25 percentageless than the initial value.
5.Again S1 is closed immediately before the motor reaches to zero speed and rheostats are adjusted until the motor reaches its rated speed
6.Then S1 is opened and at a time S2 is closed at this instant record the readings of ammeter and also note down the time taken to reach the armature voltage to a voltage of 25 percentage less than the initial voltage.
7.Gradually, reduce the armature voltage of the prime mover and then switch off the Supply

S_1 close and S_2 open

S No	Vs (Volts)	I_f(A)	Time (t1)

S_1 open at a time S_2 close

S No	Va (Volts)	I_a(A)	Time (t2)

Table11.1 Measured Values

11.7 Calculations

RETARDATION TEST Rotational losses or stray losses PS=PS1(t2/t1-t2)
PS1 = Vavg ILavg
Input power = V IL
IL = full load current of the motor

Armature cu losses = Ia2 Ra
Ia = IL-If
Total losses = Armature cu losses + Stray losses
Output power=Input -Total losses Motor efficiency = output/input.

11.8 Probing Further Experiments

Q1.Design a DC Shunt motor bu usung the values of A retardation test is carried out on a 1000 r.p.m. DC. machine. the time taken for the speed to fall from 1030 r.p.m. to 970 r.p.m.

Q2. Design the DC shunt Motor byapplying retardation test and using labview to verify the different type of characteristics.

LAB-12 SEPARATION OF CORE LOSSES IN DC SHUNT MOTOR

12.1 Introduction

As iron core of the armature is rotating in magnetic field, some losses occurs in the core which is called core losses. Normally, machines are operated with constant speed, so these losses are almost constant. These losses are categorized in two form; Hysteresis loss and Eddy current loss

12.2 Objective

To perform suitable tests on the given DC shunt machine and determine from the experiment the stray losses and separates these into friction, hysterics and eddy current losses

12.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

12.4 Equipment needed

1. Three digital voltmeters (0-300v MC Type), three digital ammeters (0-20A MC Type), a set of sheathed banana cables and a power quality meter from the stockroom
2. One tachometer from the stockroom.
3. HMRL Adjustable Load Cart.
4. A bench mounted Motor-Generator set
5. A bench mounted Multi-Range DC Power Supply (PSW 250-4.5)
6. Connecting Wires.

12.5 Background

As iron core of the armature is rotating in magnetic field, some losses occur in the core which is called core losses. Normally, machines are operated with constant speed, so these losses are almost constant. These losses are categorized in two form; Hysteresis loss and Eddy current loss. Hysteresis losses occur in the armature winding due to reversal of magnetization of the core. When the core of the armature exposed to the magnetic field, it undergoes one complete rotation of magnetic reversal. The portion of the armature which is under S-pole, after completing half electrical revolution, the same piece will be under the N-pole, and the magnetic lines are reversed in order to overturn the magnetism within the core. The constant process of magnetic reversal in the armature, consume some amount of energy which is called hysteresis loss. The percentage of loss depends upon the quality and volume of the iron.

12.6 Procedure

SEPARATION OF CORE LOSSES IN DC SHUNT MOTOR

1. Make the connections as shown in the circuit diagram.

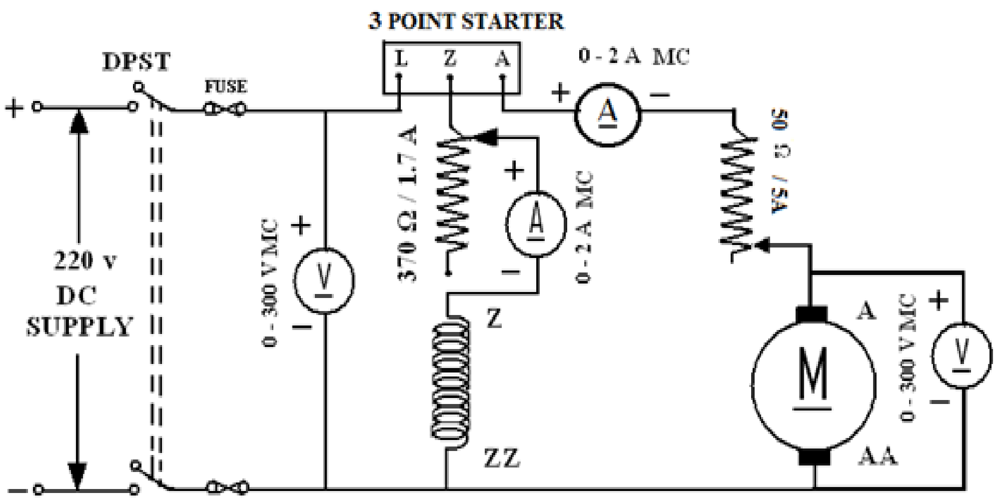

Figure 12.1 seperation of core losses

2. Start the motor slowly using starter keeping the field and armature rheostats in minimum and maximum position respectively.
3.Adjust the field current to the rated value at no- load.
4.By increasing the armature circuit resistance in steps.
5.Take the readings of voltmeter, ammeter and speed at constant field current.
6.The above step is repeated for different values of speed then tabulates the readings.
7.Bring the armature rheostat back to full resistance (initial) position
Normal Field Current (If1) =

S.No.	N(rpm)	Va(Volt)	I_a(Amp)	E_b =Va-Ia Ra	W=E_b Ia	$\frac{W}{N}$
1						
2						
3						
4						
5						

Table 12.1 Measured Values

8.Repeat the experiment with a reduced field current. (75 percentage rated excitation). 9. Tabulate armature resistance with the help of Multimeter

S.No.	N(rpm)	Va(Volt)	I_a(Amp)	E_b =Va-Ia Ra	W=E_b Ia	$\frac{W}{N}$
1						
2						
3						
4						
5						

Table 12.2 Measured Values

12.7 Calculations

seperation of core losses DC machine is running at no load by varying the speed Keeping the excitation constant speed is the speed at the motor for Rated field current (If1).
Frictional losses propotional to N1
Windage losses propotional to N12
Mechanical losses = AN1+B N12
Hysteresis losses = C1N1
Eddy current losses= D1 N12
W1/N1=(A+C1)+(B+D1)N1
For Reduced field current (If2)
C2N2= Hysteresis loss
D2 N22= Eddy current loss
W2/N2=(A+C2)+(B+D2)N2
From graph OP= A+C1
OR= A+C2
OP-OR= C1-C2 —————————- (1)
Tanpi1=B+D1; Tanpi2= B+D2
Tanpi1- Tanpi2=D1-D2—————————— (2)
C1/C2= (If1/If2)1.6—————————- (3)
D1/D2= (If1/If2)2—————————— (4)

At rated speed the various losses are results
Hysteresis loss = ... W
Eddy Current loss = ... W
Friction loss = ... W
Wind age loss = ... W

12.8 Model graphs

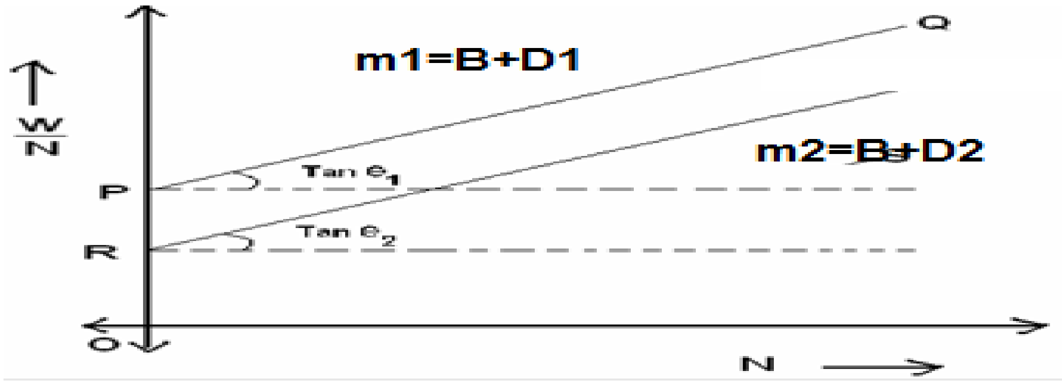

Figure 12.2:seperation of core losses

12.9 Probing Further Experiments

Q1.Design the DC motor to seperate the core losses by using mathematical equtions .

Q2. Calcuate the seperation of core losses by using LabVIEW.

LAB-13 MAGNETIZATION CHARACTERISTIC OF DC SHUNT GENERATOR BY USING DIGITAL SIMULATION

13.1 Introduction

The open circuit characteristics for a DC generator are determined as follows. The field winding of the DC generator (series or shunt) is disconnected from the machine and is separately excited from an external DC source. The generator is run at fixed speed (i.e. rated speed).

13.2 Objective

To determine experimentally the magnetization or open circuit characteristic of a D.C Shunt generator and to determine the critical field resistance and critical speed, by using simscape power systems

13.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

13.4 Equipment needed

1. Simscape power systems
2. Desktop computer systems, Dual Core processor, 2GB RAM, 320GB hard disk.

13.5 Background

A DC generator, whose schematic equivalent circuit is shown in figure 1, is an electrical machine that converts the mechanical energy of a prime mover (e.g. DC motor, AC induction motor or a turbine) into direct electrical energy. The generator shown in figure 1 is self-exciting. It uses the voltage Ea generated by the machine to establish the field current If, which in turn gives rise to the magnetic-field flux. When the armature winding rotates in this magnetic field so to cut the flux, the voltage Ea is induced in the armature. This voltage is commonly referred to as the armature electromotive force or EMF. The induced EMF is proportional to the rate of cutting the flux and is given by emf formula.

13.6 Procedure

Magnetization Characteristics of DC shunt motor
1.Connect the circuit as per the figure using simscape power systems.

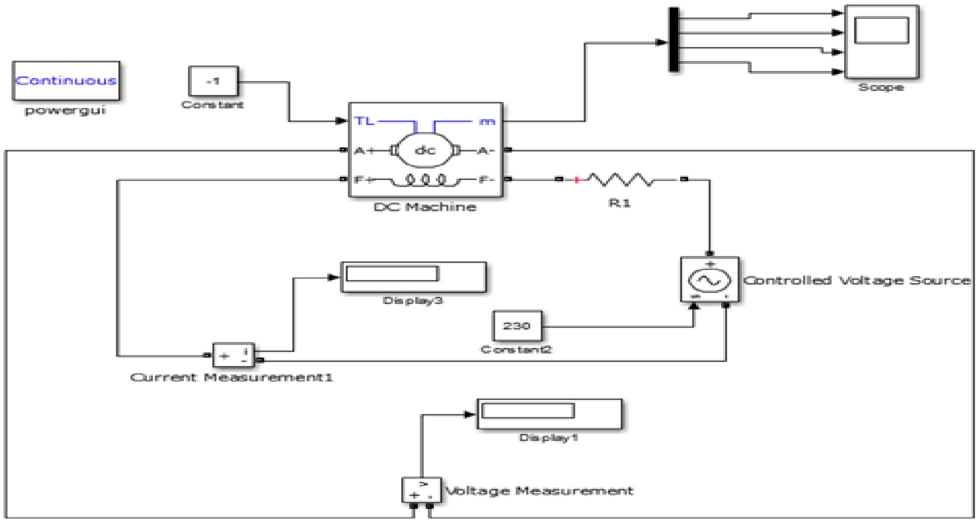

Figure 12.1 seperation of core losses

2. Note down the readings of ammeter and voltmeter by varying field rheostat in steps.
3.Draw the Open circuit characteristics between field current and no load voltage.

S.No.	ASCENDING	
	Field Current (Amp)	Generated Voltage (Volts)
1		
2		
3		
4		
5		
6		
7		

Table 13.1 Measured Values

13.7 Model graphs

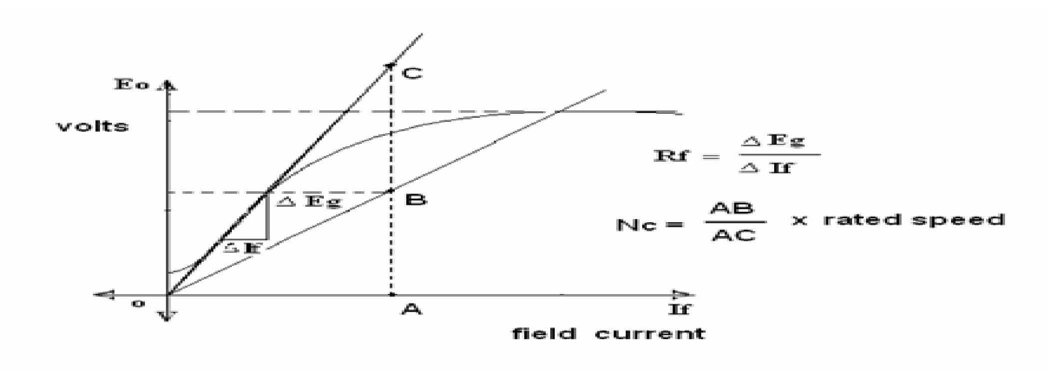

Figure 13.2: Magnetization Characteristics Curve

13.8 Probing Further Experiments

Q1.Design the DC shunt generator to analyze magnetization characteristics and to calculate the critical speed and critical resistance.

Q2. Calcuate the critical speed and critical resistance by using LabVIEW.

LAB-14 LOAD TEST ON DC SHUNT GENERATOR BY USING DIGITAL SIMULATION

14.1 Introduction

A load test on a DC shunt generator is conducted to know the performance. It is done specifically to know the internal and external characteristics. The external characteristics are known by drawing a graph between the terminal voltage and the load current.

14.2 Objective

To draw the external characteristics of shunt generator, by using sims cape power systems

14.3 Prelab Preparation:

Read the Introduction and procedure of the experiment of respective experiments which are given this manual

14.4 Equipment needed

1. Simscape power systems
2. Desktop computer systems, Dual Core processor, 2GB RAM, 320GB hard disk.

14.5 Background

In a shunt generator, the field winding is connected in parallel with the armature winding so that terminal voltage of the generator is applied across it. The shunt field winding has many turns of fine wire having high resistance. Therefore, only a part of armature current flows through shunt field winding and the rest flows through the load. Figure shows the connections of a shunt wound generator. The armature current Ia splits up into two parts; a small fraction Ish flowing through shunt field winding while the major part IL goes to the external load.

14.6 Procedure

Load Test on DC shunt Generator
1.Connect the circuit as per the figure using simscape power systems.

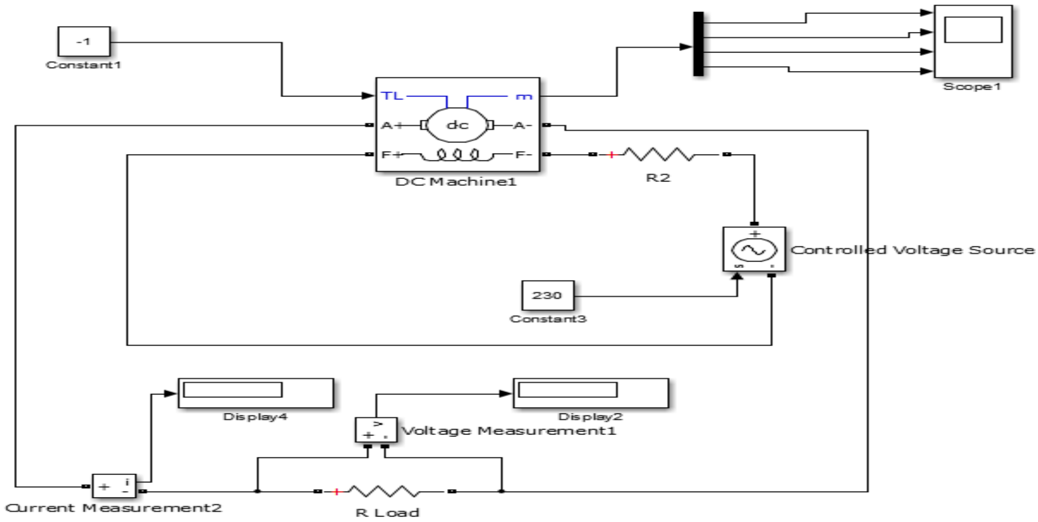

Figure 12.1 seperation of core losses

2.Note down the readings of ammeter and voltmeter by varying R load in steps.
3.3. Draw the external characteristics between load current and load voltage.

S.No	I_L(Amp)	V_L(Volt)
1		
2		
3		
4		

Table 14.1 Measured Values

14.7 Model graphs

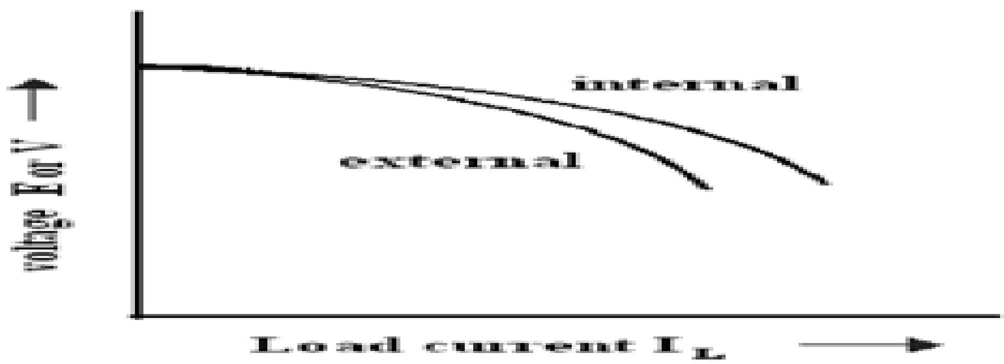

Figure 14.2: Generated Voltage Vs Field Current

14.8 Probing Further Experiments

Q1.Design the DC shunt generator to analyze characteristics and to calculate efficeiency by using digital simulation.

Q2. Calcuate the efficency of DC Shunt motor by conducting brake test by using LabVIEW.