DC MACHINES LABORATORY

III Semester: EEE								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AEEC09	**Core**	-	-	3	1.5	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: There are no prerequisites to take this course								

I. COURSE OVERVIEW:

This laboratory course is to meet the requirements of practical work meant for basic operation, analysis and design of electrical machines. It provides hands-on experience by examining the electrical and mechanical characteristics of various DC machines. Analyze the characteristics of DC machines and separate the various losses in electrical machines by conducting different tests.

II. COURSES OBJECTIVES:

The students will try to learn

I. The elementary experimental and modelling skills for handling problems with electrical machines in the industries and domestic applications to excel in professional career.
II. The operation of DC Machines and its role in power transmission and distribution.
III. The intuitive knowledge needed to test and analyze the performance leading to design of electric machines by conducting various tests and calculate the performance parameters.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1: Analyze the performance characteristics of dc machine under various loading conditions.
CO 2: Determine the critical field resistance and speed of dc shunt generator using open circuit characteristics.
CO 3: Examine the performance of DC shunt machine with different speed control techniques and predetermine the efficiency.
CO 4: Estimate and separate the core losses in dc machine by conducting a suitable test.
CO 5: Examine the performance and speed control of dc machines using simulation tools.

DO's

1. Once the operation is completed pull the plug itself rather chord attached to it.
2. To repair the equipment switch-off the supply and go on.
3. To operate the equipment on supply, see that hands are dry, if that is not possibly hide the hand in the pockets.
4. If a person comes in contact with current unexpectedly don't touch the person with hands but immediately use any insulator material and shut down the power (like leather belts, wood and plastic bars etc).
5. If water is nozzles on the equipment, immediately shunt down the power using circuit breaker or pull out the plug.
6. Use the connecting wires of good continuity, short circuit of connecting wire leads damage of circuit parameters

DON'Ts

1. Do not wear loose clothing and do not hold any conducting materials in contact with skin when the power is on.
2. Do not pull out the connections until unless all the currents are dead.
3. Do not wait for switches to de-magnetize when there is a delay but pull out the plug.
4. Do not overload the circuit by plugging in too many appliances.
5. If you are mentally and physically stressed don't operate the power equipment.
6. Never operate the equipment under wet conditions.
7. Do not interconnect two or more wires, take appropriate length of wire.

SAFETY NORMS

1. The lab must be equipped with fire extinguisher.
2. See that the connections are made tight.
3. Use single plug for each equipment.
4. Cover the body completely to avoid arc effect.
5. To change the connections during the experiment, switch off the supply and carry on.
6. Used equipment may get heated, so take care handling the equipment after it is used.
7. Do the wiring, all set ups and check the circuit connections before the supply is on

IV. COURSE SYLLABUS:

EXERCISES FOR ELECTRICAL DC MACHINES LABORATORY

Note: Students are encouraged to bring their own laptops for laboratory practice session

1. OPEN CIRCUIT CHARACTERISTICS OF DC SHUNT GENERATOR.

Develop the circuit for analyzing the characteristics of DC shunt generator

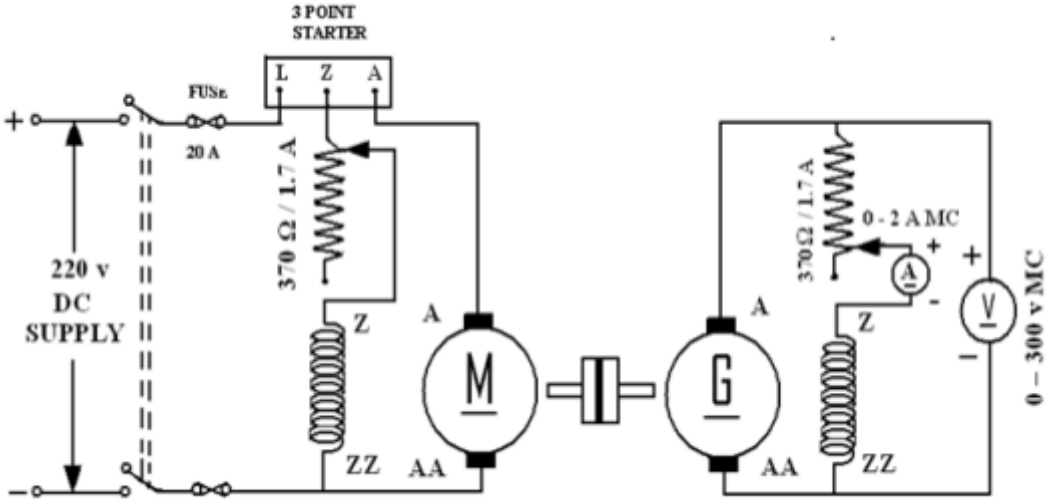

Figure 1 - MAGNETIZATION CHARACTERISTIC

Try

1. From the Open circuit characteristics calculate the critical resistance of field winding.
2. Using magnetization characteristics calculate the critical speed of DC shunt generator at 100 ohms in figure 1.
3. Determine the performance of DC generator using the magnetization curve.
4. Calculate the critical value of shunt field resistance at 1500 rpm.

2. LOAD TEST ON DC SHUNT GENERATOR

Design the DC shunt generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine

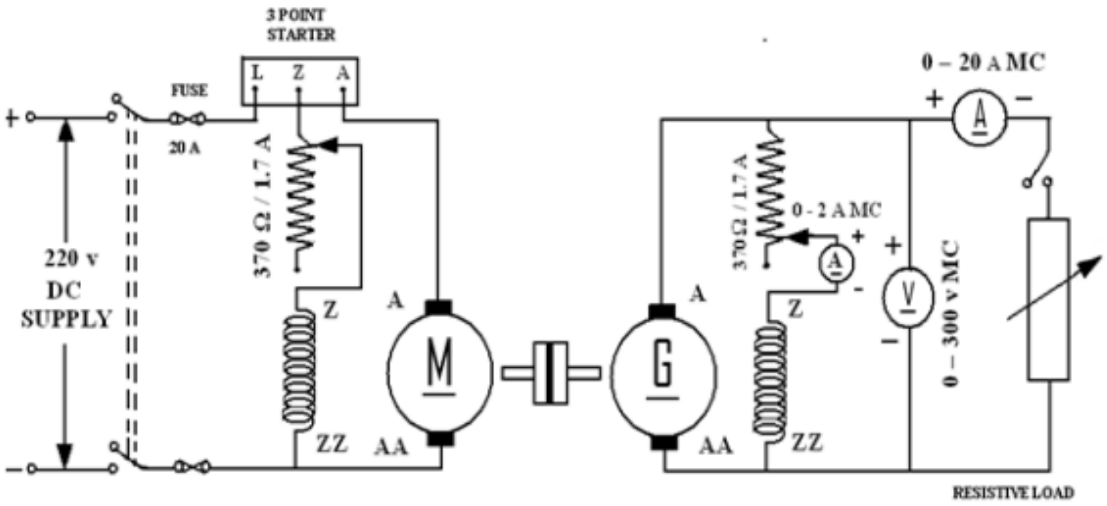

Figure 2 - LOAD TEST ON DC SHUNT GENERATOR

Try

1. Calculate the different armature currents (i.e ia equal il plus if) for shunt generator under various loads in figure 2.
2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents.
3. Draw the Internal characteristics using generated induced emf (0 to 220V) with respect to the field currents (0 to 2A).

3. LOAD TEST ON DC SERIES GENERATOR

Design the DC series generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine

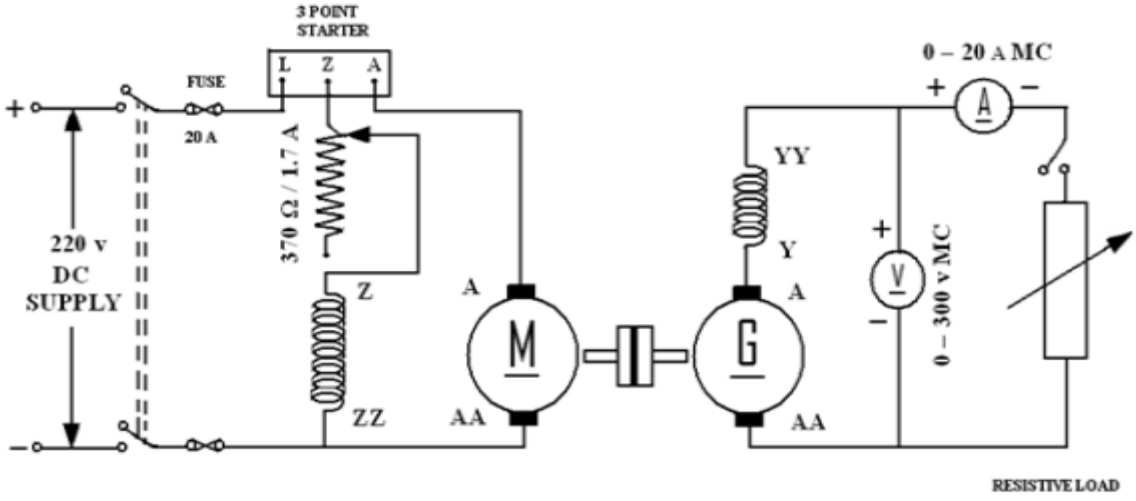

Figure 3 - LOAD TEST ON DC SERIES GENERATOR

Try

1. Calculate the different armature currents (i.e I_a equal I_a plus if) for series generator under various Loads In figure 3
2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents.
3. Draw the Internal characteristics using generated induced emf (0 to 220V) with respect to the field currents (0 to 2A).

4. LOAD TEST ON DC COMPOUND GENERATOR

Design the DC compound generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine

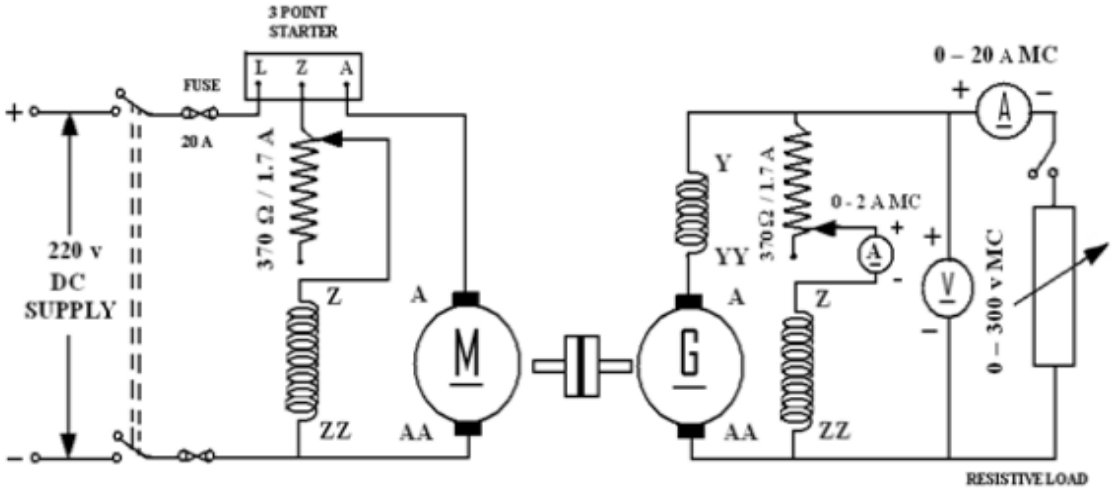

Figure 4 - LOAD TEST ON DC COMPOUND GENERATOR

Try

1. Calculate the different armature currents (i.e ia equal il plus if) for compound generator under various loads in figure 4
2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents.
3. Draw the Internal characteristics using generated induced emf(0 to 220V) with respect to the field currents (0 to 2A).

5. HOPKINSON'S TEST

Develop a method of testing for two identical dc shunt machines which are mechanically coupled and also electrically connected in parallel

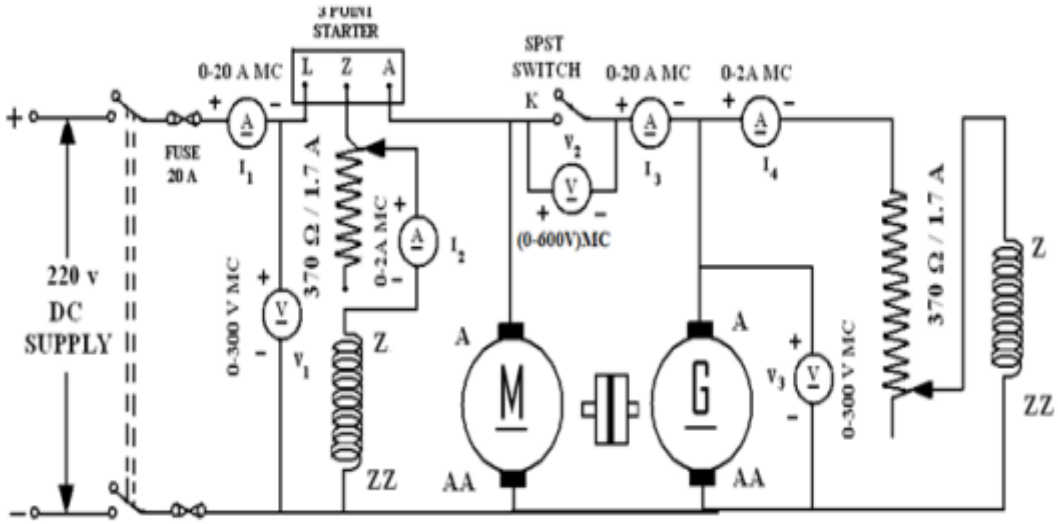

Figure 5 - Identical DC Shunt Machines

Try

1. Calculate the efficiency of two identical dc shunt machines if the armature resistance of each machine is 0.025 ohms, line voltage of 230V and line current excluding both the field currents 2A, motor armature current 10A, field current 1A and 2A figure 5.
2. Draw the performance characteristics of two identical dc shunt machines.
3. Find the iron losses depend on the emf generated in the armature

6. FIELD'S TEST

1. Develop a method of testing for two similar dc series machines depend on the accuracy with which the motor input and generator output are measured
2. Determine load or unknown current through a R_4 resistor using Thevenin's equivalent circuit.

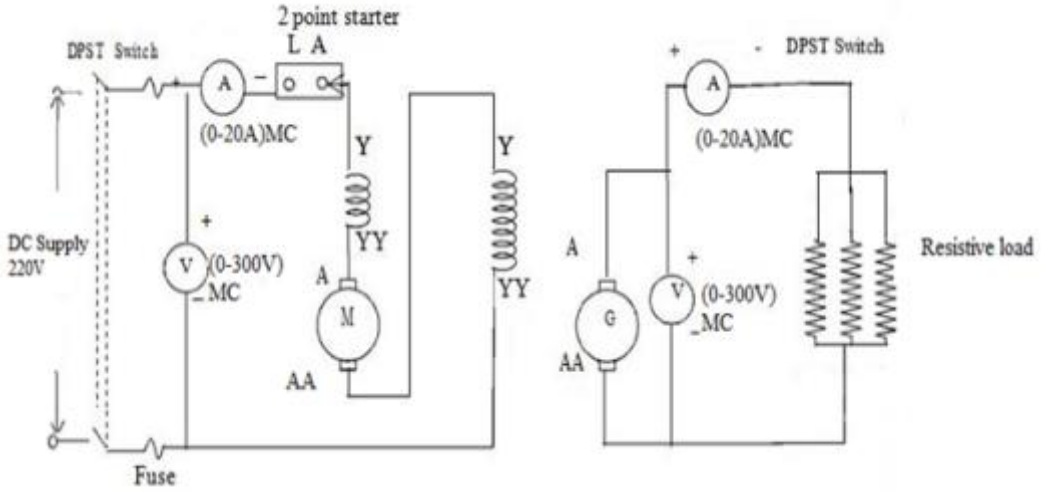

Figure 6 - Identical DC Shunt Machines

Try

1. Calculate the efficiency of both dc series machines if the armature resistance of each machine is 2 ohms in figure 6
2. Draw the performance characteristics of two dc series machines.
3. Find the no load rotational losses of both the machines and total losses in the whole set.

7. SWINBURNE'S TEST AND SPEED CONTROL OF DC SHUNT MOTOR

1. Design the suitable test under no load conditions to measure no load losses inDc shunt machines and speed control of DC shunt motor.

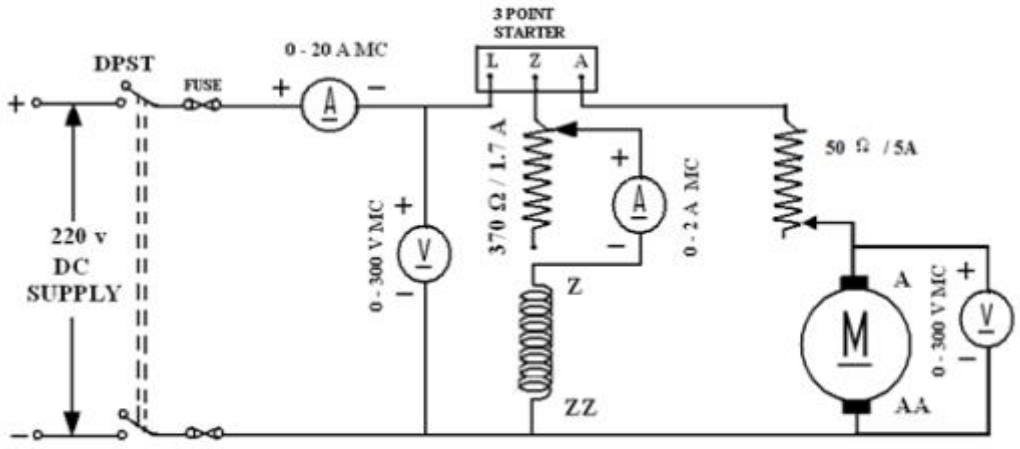

Figure 7 - Speed control of DC motor

Try

1. Calculate the output power and efficiency when motor takes 10A on full load and 5A on half Load in figure 7.
2. Measure the no load machine losses by using indirect method of testing.
3. Perform the speed control by varying the armature circuit resistance and field circuit resistance of DC shunt motor.

8. BRAKE TEST ON DC COMPOUND MOTOR

Develop the circuit for conducting brake test on DC compound motor.

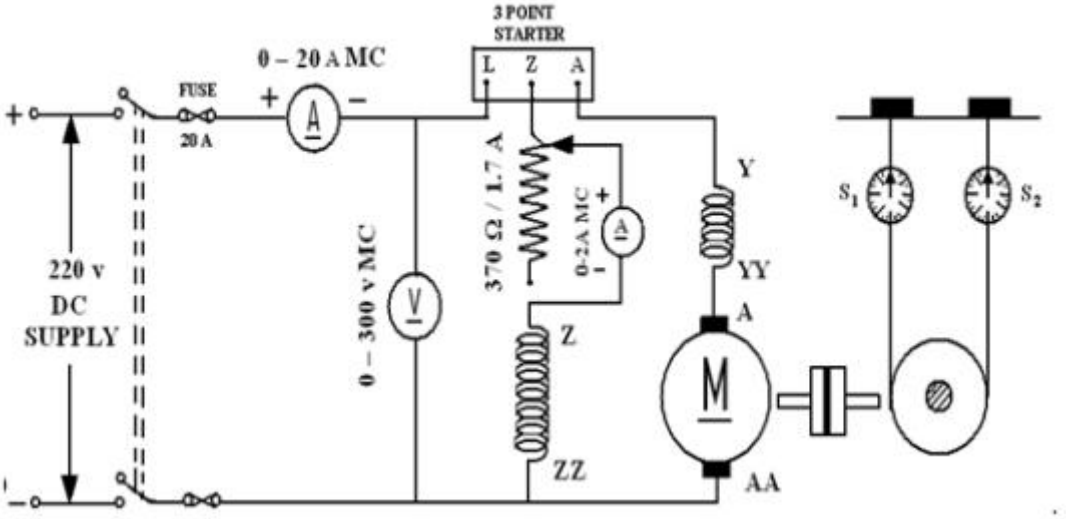

Figure 8 - Brake test on DC compound motor

Try

1. Calculate the efficiency of DC compound motor under different load conditions in figure 8
2. Calculate the shaft torque and shaft power at rated load.
3. Determine the mechanical output power under different weights.

9. BRAKE TEST ON DC SHUNT MOTOR

Develop the circuit for conducting brake test on DC shunt motor

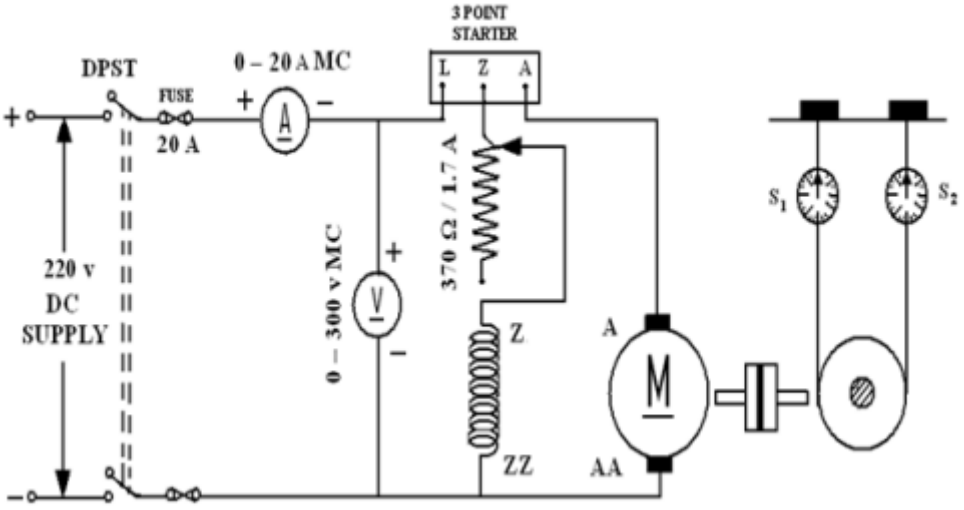

Figure 9 - Brake test on DC shunt motor

Try

1. Calculate the efficiency of DC shunt motor under different load conditions.
2. Calculate the shaft torque and shaft power at rated load.
3. Determine the mechanical output power under different weights

10. RETARDATION TEST

Develop the test for separating the mechanical losses of the DC shunt machine

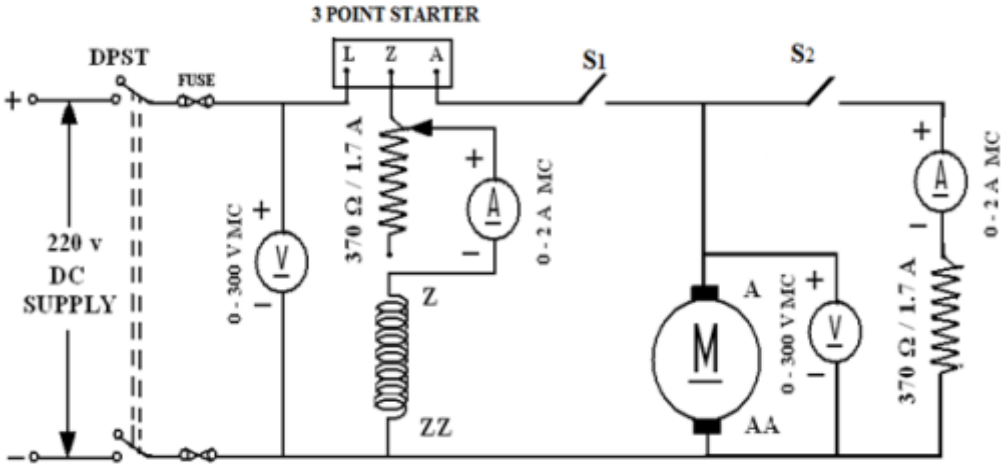

Figure 10 - Retardation Test

Try

1. Find the rotational losses i.e. friction, wind age and iron losses.
2. Measure the moment of inertia of the armature under normal speed of a DC machine 1000rpm.
3. Calculate the efficiency of DC shunt machine when time taken for the speed to fall from 1030 rpm to 970 rpm is 15 seconds with field normally excited in figure 10.

11. SEPARATION OF LOSSES IN DC SHUNT MOTOR

Design the circuit for separating the iron losses in DC shunt motor.

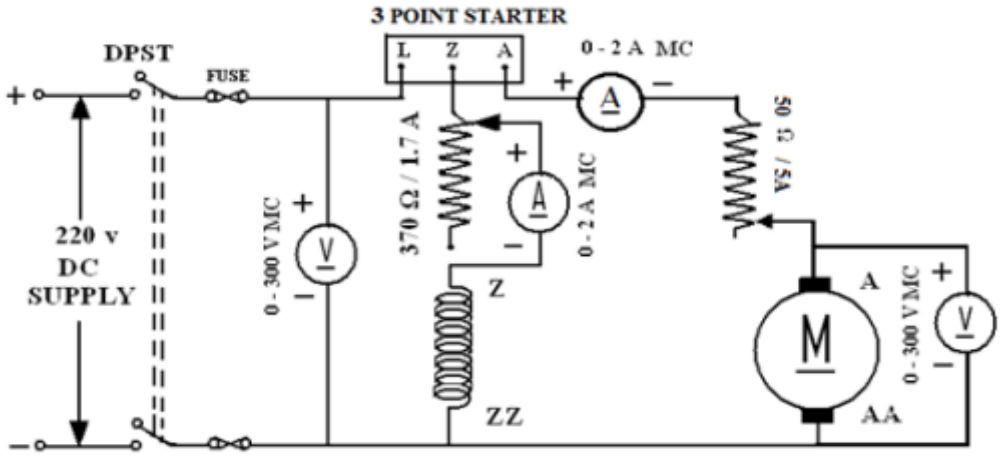

Figure 11 - Figure 9 - separation of core losses

Try

1. Calculate the hysteresis and eddy current losses in Dc shunt motor.
2. Draw the curve for total iron losses for various field currents.

12. MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR USING DIGITAL SIMULATION

1. Develop the circuit for analyzing the magnetization characteristics of DC shunt generator using Digital simulation.

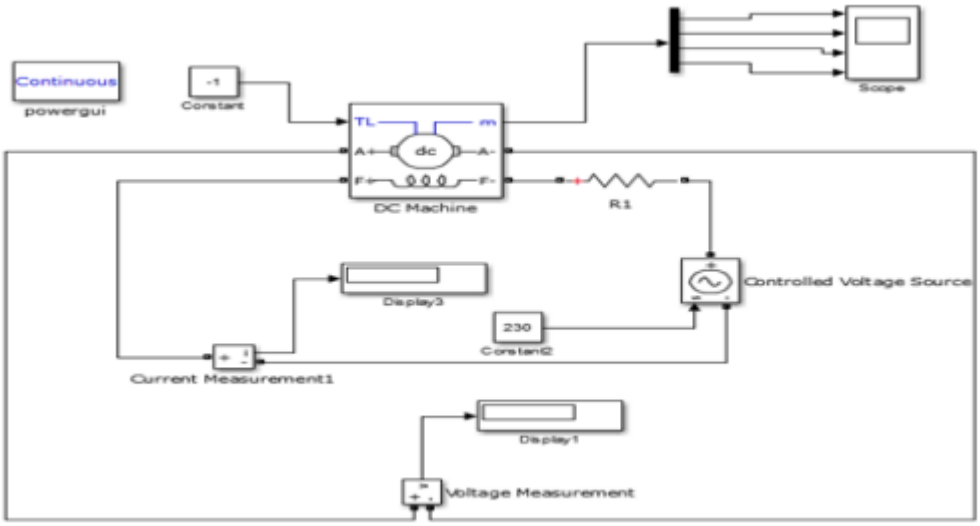

Figure – 12 separation of core losses

Try

1. From the Open circuit characteristics calculate the critical resistance of field winding.
2. Using magnetization characteristics calculate the critical speed of DC shunt generator at 100 ohms.
3. Determine the performance of DC generator using the magnetization curve.
4. Calculate the critical value of shunt field resistance at 1500 rpm

13. LOAD TEST ON DC SHUNT GENERATOR USING DIGITAL SIMULATION

Design the DC shunt generator circuit under full, 3/4th, half and 1/4th load conditions for analyzing the performance of the machine using Digital simulation.

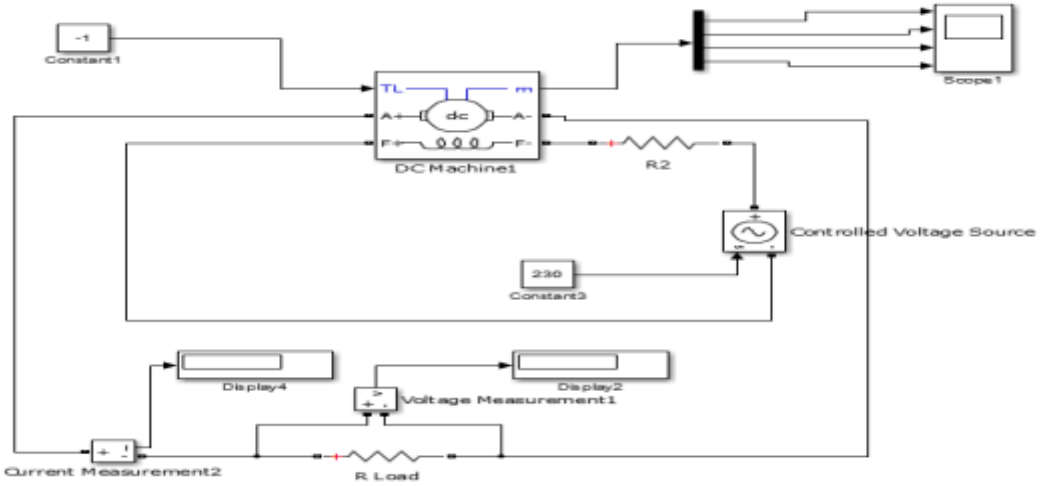

Figure – 13 separation of core losses

Try

1. Calculate the different armature currents (i.e i_a equal i_l plus i_f) for shunt generator under various loads.
2. Draw the External characteristics using armature currents (0 to 13 A) with respect to the load currents
3. Draw the Internal characteristics using generated induced emf (0 to 220V) with respect to the field currents (0 to 2A).

14. SPEED CONTROL OF DC SHUNT MOTOR USING DIGITAL SIMULATION

Design the suitable test for speed control of DC shunt motor using MATAB.

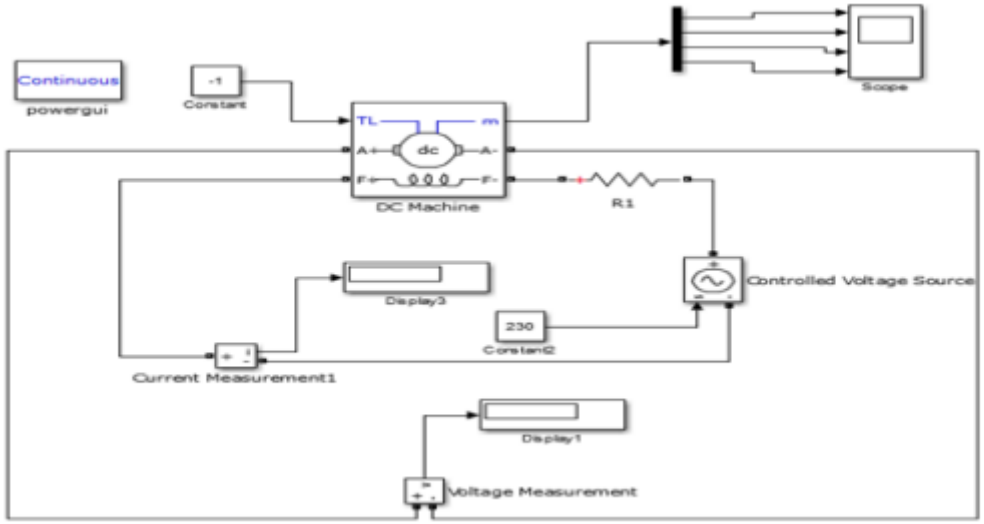

Figure – 14 speed control for various loads

Try

1. Perform the speed control by varying the armature circuit resistance of DC shunt motor.
2. Perform the speed control by varying the field circuit resistance of DC shunt motor.

V. TEXT BOOKS:

1. A Chakrabarti, "*Circuit Theory*", Dhanpat Rai Publications, 8th Edition, 2021.
2. William Hayt, Jack E Kemmerly S.M. Durbin, "*Engineering Circuit Analysis*", Tata McGraw Hill, 9th Edition, 2020.

VI. REFERENCE BOOKS:

1. CL Wadhwa, *Electrical Circuit Analysis including Passive Network Synthesis*, International, 2nd Edition, 2009.
2. David A Bell, *Electric circuits*, Oxford University Press, 7th Edition, 2009.

VII. ELECTRONICS RESOURCES:

1. https://www.allaboutcircuits.com/textbook/
2. https://onlinecourses.nptel.ac.in/noc22_ee93/preview
3. https://www.iare.ac.in

VIII. MATERIALS ONLINE

1. Course template
2. Lab manual