DRONACHARYA
Group of Institutions

ELECTRICAL MACHINES-I
LABORATORY MANUAL

B.Tech. Semester

Subject Code: BEE-452

Session: 2024-25, Even Semester

Name:	
Roll. No.:	
Group/Branch:	

DRONACHARYA GROUP OF INSTITUTIONS
DEPARTMENT OF EEE
#27 KNOWLEDGE PARK 3

GREATER NOIDA

AFFILATED TO Dr. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

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Vision and Mission of the Institute

Vision:

"Dronacharya Group of Institutions, Greater Noida aims to become an Institution of excellence in imparting quality Outcome Based Education that empowers the young generation with Knowledge, Skills, Research, Aptitude and Ethical values to solve Contemporary Challenging Problems"

Mission:

M1: To prepare students for full and ethical participation in a diverse society and encourage lifelong learning by following the principle of 'Shiksha evam Sahayata' i.e. Education and Help.

M2: To impart high-quality education, knowledge and technology through rigorous academic programs, cutting-edge research, and industry collaborations, with a focus on producing engineers and managers who are socially responsible, globally aware, and equipped to address complex challenges.

M3: Educate students in the best practices of the field as well as integrate the latest research into the academics.

M4: Provide quality learning experiences through effective classroom practices, innovative teaching practices, and opportunities for meaningful interactions between students and faculty.

M5: To devise and implement programmes of education in technology and management that are relevant to the changing needs of society, in terms of breadth of diversity and depth of specialization.

Vision and Mission of the Department

VISION

V 1: To be recognised as a department of excellence to produce competent and ethical students with a worldwide competency and shape them for industry, research, entrepreneurship and higher academic goals.

V 2: The department's goal is to help students find, innovate, create, and produce environmentally friendly and socially responsible technology that fulfils the increasing demands of industry.

MISSION

M 1: To impart to students technical and ethical knowledge to help them design, implement and control efficient systems and also comprehend the industry's expanding issues.

M 2: Make every endeavour to engage with academic groups and industry to provide the framework for collaborative researc

Programme Educational Objectives (PEOs)

PEO 1. Engineers will practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams.

PEO 2. Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, and an ability to engage in continuing professional development and life-long learning.

PEO 3. Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects affect society and the environment.

PEO 4. Promote Design, Research, and implementation of products and services in the field of Engineering through Strong Communication and Entrepreneurial Skills.

PEO 5. Re-learn and innovate in ever-changing global economic and technological environments of the 21st century.

Programme Outcomes (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Develop applications in the areas of Electrical and Electronics Engineering based on the knowledge of Control systems and automation, Electrical machines, Power systems, and Embedded Systems.

PSO2: Ability to design, analyse, integrate and synthesize different novel systems to be capable for lifelong learning and advanced industrial research.

PSO3: Be proficient enough to make use of the technical concepts, suitable methods and algorithms for research as well as for the social needs.

University Syllabus

1. To obtain magnetization characteristics of a DC shunt generator.

2. To obtain load characteristics of a DC shunt generator and compound generator (a)

Cumulatively compounded (b) Differentially compounded.

3. To obtain efficiency of a DC shunt machine using Swinburne's test.

4. To perform Hopkinson's test and determine losses and efficiency of DC machine.

5. To obtain speed- torque characteristics of a DC shunt motor.

6. To obtain speed control of DC shunt motor using (a) armature resistance control (b) field control

7. To obtain speed control of DC separately excited motor using Ward-Leonard.

8. To obtain equivalent circuit, efficiency and voltage regulation of a single-phase

transformer using O.C. and S.C. tests.

9. To obtain efficiency and voltage regulation of a single-phase transformer by Sumpner's test.

10. To obtain 3-phase to2-phase conversion by Scott connection.

11. To demonstrate the parallel operation of three phase transformer and to obtain the load sharing at a load.

Course Outcomes (COs)

Upon successful completion of the course, the students will be able to:

CO 1	Analyze and conduct basic tests on DC Machines and single-phase Transformer
CO 2	Obtain the performance indices using standard analytical as well as graphical methods
CO 3	Determine the magnetization, Load and speed-torque characteristics of DC Machines
CO 4	Demonstrate procedures and analysis techniques to perform electromagnetic and electromechanical tests on electrical machines.
CO 5	Analyze and conduct basic tests on DC Machines and single-phase Transformer

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	-	-	-	1	-	1	1	1	2	2	2
CO 2	3	2	-	-	2	2	1	2	1	2	2	2
CO 3	2	2	2	2	-	2	1	-	1	1	1	1
CO 4	2	-	2	2	2	-	1	2	1	1	1	1
CO 5	1	2	3	2	2	2	1	2	1	1	2	2
Course Correlation mapping	2.2	1.2	1.4	1.2	1.4	1.2	1	1.4	1	1.4	1.6	1.6

Correlation Levels: High-3, Medium-2, Low-1

CO-PSO Mapping

	PSO1	PSO2	PSO3
CO 1	2	3	1
CO 2	2	3	1
CO 3	2	3	1
CO 4	2	3	1
CO 5	2	3	1

Course Overview

Electromechanical Energy Conversion (EMEC) Laboratory is the one the oldest and important laboratory of Electrical Engineering Department. The lab is equipped with conventional and modern electrical& electronic measuring equipment's and ac & dc electrical machines. In the lab students' study, learn & perform the experiments on different types of electrical machines such as - transformers, Synchronous motors, alternators, dc motors & generators, three phase and single-phase induction motors, relays and controlled rectifiers to verify the different characteristics of the electrical machines

List of Experiments mapped with COs

Si No.	Name of the Experiment	Course Outcome
1	To obtain magnetization characteristics of a d.c. shunt generator.	CO 2
2	To obtain load characteristics of a d.c. shunt generator.	CO 2
3	To obtain load characteristics of a d.c. shunt generator and compound generator (a) Cumulatively compounded (b) Differentially compounded.	CO 2
4	To obtain efficiency of a dc shunt machine using Swinburn's test.	CO 3
5	To perform Hopkinson's test and determine losses and efficiency of DC machine.	CO 3
6	To obtain speed-torque characteristics of a dc shunt motor.	CO 3
7	To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control.	CO 3
8	To obtain equivalent circuit, efficiency and voltage regulation of a single-phase transformer using O.C. and S.C. tests.	CO 4
9	To study Speed control of slipring Induction Motor	CO 4
10	To obtain speed control of dc excited motor using Conventional Ward-Leonard/Static Ward –Leonard method.	CO3

DOs and DON'Ts

DOs

1. Login-on with your username and password.

2. Log off the computer every time when you leave the Lab.

3. Arrange your chair properly when you are leaving the lab.

4. Put your bags in the designated area.

5. Ask permission to print.

DON'Ts

1. Do not share your username and password.

2. Do not remove or disconnect cables or hardware parts.

3. Do not personalize the computer setting.

4. Do not run programs that continue to execute after you log off.

5. Do not download or install any programs, games or music on computer in Lab.

6. Personal Internet use chat room for Instant Messaging (IM) and Sites is strictly prohibited.

7. No Internet gaming activities allowed.

8. Tea, Coffee, Water & Eatables are not allowed in the Computer Lab.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.
2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.
3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.
4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.
2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.
3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.
4. Call security and emergency department immediately:

   Emergency : **201 (Reception)**

   Security : **231 (Gate No.1)**

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows: -

1) All files must contain a title page followed by an index page. ***The files will not be signed by the faculty without an entry in the index page.***

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages.

3) For each experiment, the record must contain the following

        (i) Aim/Objective of the experiment
        (ii) Pre-experiment work (as given by the faculty)
        (iii) Lab assignment questions and their solutions
        (iv) Test Cases (if applicable to the course)
        (v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment aswell as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Designing experiments	The student chooses the problems to explore.	The student chooses the problems but does not set an appropriate goal for how to explore them.	The student fails to define the problem adequately.	The student does not identify the problem.
AC2: Collecting data through observation and/or experimentation	Develops a clear procedure for investigating the problem	Observations are completed with necessary theoretical calculations and proper identification of required components.	Observations are completed with necessary theoretical calculations but without proper understanding. Obtain the correct values for only a few components after calculations. Followed the given experimental procedures but obtained results with some errors.	Observations are incomplete. Lacks the appropriate knowledge of the lab procedures.
AC3: Interpreting data	Decides what data and observations are to be collected and verified	Can decide what data and observations are to be collected but lacks the knowledge to verify	Student decides what data to gather but not sufficient	Student has no knowledge of what data and observations are to be collected
AC4: Drawing conclusions	Interprets and analyses the data in order to propose viable conclusions and solutions	Incomplete analysis of data hence the quality of conclusions drawn is not up to the mark	Cannot analyse the data or observations for any kind of conclusions.	Lacks the required knowledge to propose viable conclusions and solutions
AC5: Lab record assessment	Well-organized and confident presentation of record & ability to correlate the theoretical concepts with the concerned lab results with appropriate reasons.	Presentation of record is acceptable	Presentation of record lacks clarity and organization	No efforts were exhibited

LAB EXPERIMENTS

LAB EXPERIMENT 1

AIM : To plot the magnetization characteristics of a DC Shunt Generator running at rated speed**.**

APPARATUS REQUIRED:

INSTRUMENTS REQUIRED (TO BE CONNECTED

EXTERNALLY) FOR DC MOTOR :-

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-10 A. – 1 No.

3. Tubular Rheostat 1.2 A. 260 Ohms – 1 No.

4. Indicating light

5. Educational type insulated terminals

6. DPIC Switch 16A, 240V.

7. D.C. Starter 3 Point - 1 No.

FOR DC GENERATOR :

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-1 A. – 1 No.

3. MC Ammeter 96 x 96 mm flush mounted 0-10 A. – 1 No.

4. Tubular Rheostat 1.1 A. 800 Ohms – 1 No.

5. Indicating light

6. Educational type insulated terminals

BRIEF THEORY: In the DC shunt generator e.m.f. generated in the armature winding

under no load operation generator e.m.f. $E_g = \dfrac{ZNP}{60A}$

$$(Where\ K = \dfrac{ZNP}{60A})$$

$(Why\ \phi \propto I_f\ )$

At constant speed no load e.m.f. (E_g) is proportional to the flux per pole (φ). But flux (φ) depends upon the field current (I_f) the characteristics curve showing the relationship between the field current and generated e.m.f. (E_g) at no load. It is known as magnetization characteristics or open circuit characteristics (O.C.C.) of DC shunt generator. A small e.m.f. (E_g) of the order to 10 to 15Volts is generated by the generator due to the residual magnetism present in the poles.

Circuit diagram
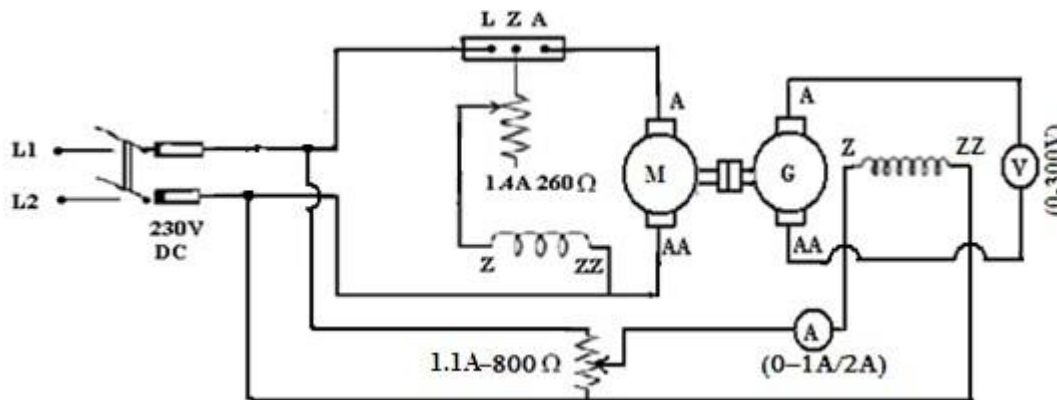
PROCEDURE:

1. Connect the DC Motor and the DC generator (coupled together) as per attached sheet.

2. Adjust the rheostat in the field circuit of the motor, so that the additional resistance in this circuit is minimum.

3. Set the potential divider feeding the field circuit of the generator for zero output voltage.

4. Switch-on the DC supply to the DC Motor and start it using the starter. Move the starter arm slowly, till the motor builds up the speed and finally cut out all the resistance steps of the starter. Starter arm will then be hold up by holding magnet of the starter.

5. Adjust the speed of the DC motor to rated value by varying the resistance in the field circuit.

6. Record the generated emf due to residual magnetism.

7. Vary the field current of generator in steps and record its value

and the corresponding generated emf of the generator. Observation should be continued upto the generated voltage.

8.   Now reduce the field current with the help of rheostat in steps and record the induced emf for decreasing values of the field current.

PANEL FOR MAGNETIZATION CHARACTERISTICS OF
DC SHUNT GENERATOR
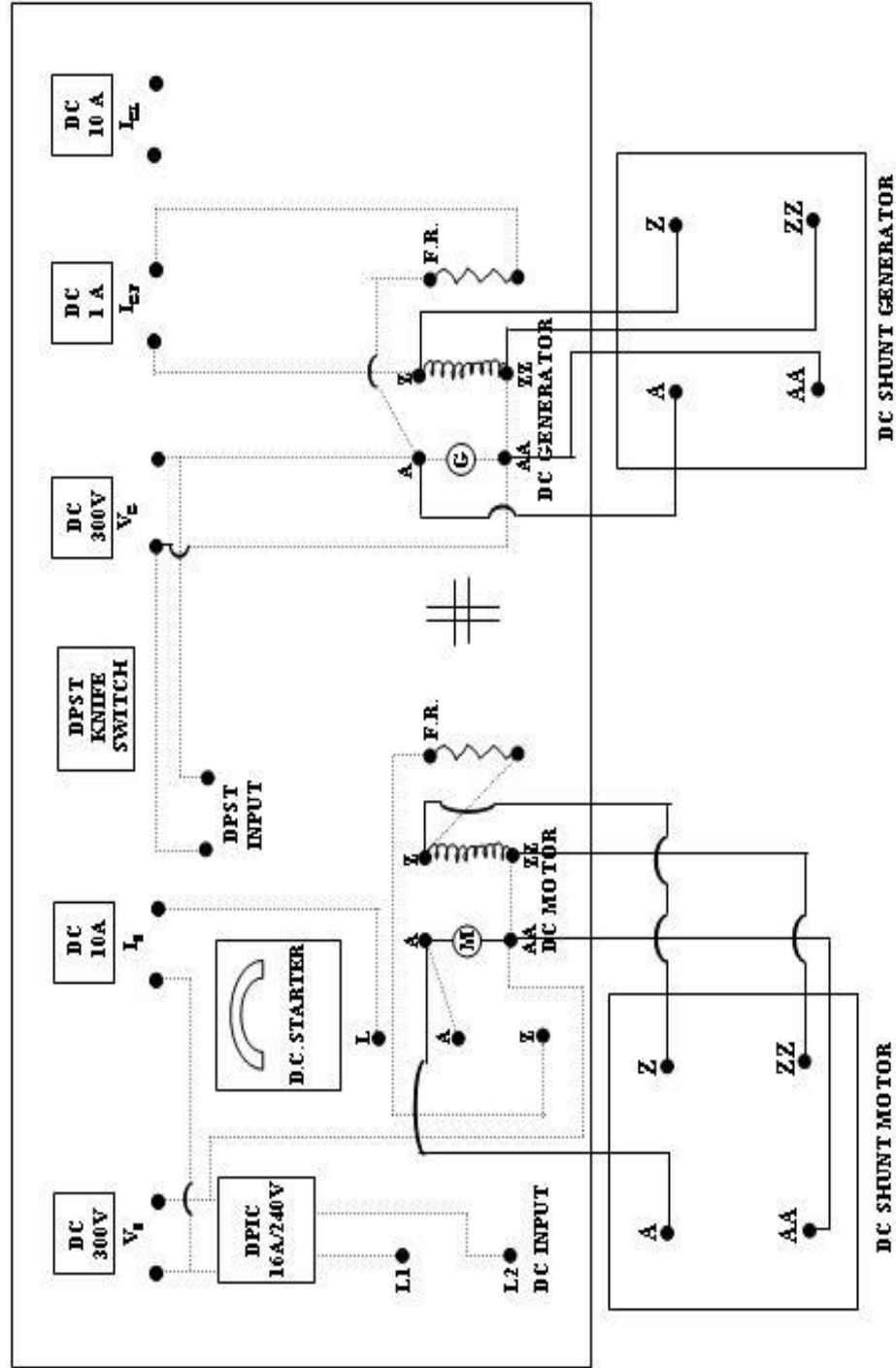
OBSERVATIONS:

MOTOR		GENERATOR		
V_S	I_S	V_G	I_{FG}	RPM

CALCULATION:

CONCLUSION: Plot the graph between field current and terminal voltage Open circuit.

LAB EXPERIMENT 2

AIM: To obtain load characteristics of a d.c. shunt generator

APPARATUS REQUIRED:

FOR DC MOTOR :-

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-10 A. – 1 No.

3. Tubular Rheostat 1.2 A. 260 Ohms – 1 No.

4. Indicating light

5. Educational type insulated terminals

6. DPIC Switch 16A, 240V.

FOR DC GENERATOR :

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-5 A. – 1 No.

3. Knife Blade Switch DPST -1 No.

4. Tubular Rheostat 1.2 A. 260 Ohms – 1 No.

5. Indicating light

6. Educational type insulated terminals

7. Lamp Bank Load 2 KW 230V in steps of 200 watts bulbs.

PRIME MOVER: **D. C. Shunt wound, 3 HP, 220/230V. 1500 RPM.**

DC GENERATOR   :   **Self excited – Shunt wound, 1.5 KW,230V, 1500 RPM.**

THEORY:

The external characteristic (load characteristic) of DC generator represents the graphical relationship between the terminal voltage and the load current, the generator being operated at constant rated speed and with the same excitation as under the no load conditions. The nature of this characteristic depends upon the following factors**.**

(i) Voltage drop in the armature winding, interpole and compensating winding

(ii) Voltage drop at the brush contact.

**(iii)** Voltage drop due to armature reaction.

External characteristic of the generator indicates the fall in the terminal voltage as the load on the generator increases. External characteristic of a shunt generator is more drooping compared to that of separately excited generator. The fall in the terminal voltage due to increase in load can be compensated by an additional winding on the field system and connected in series with the armature winding i.e. by proving series field winding, thus making the generator a compound generator.

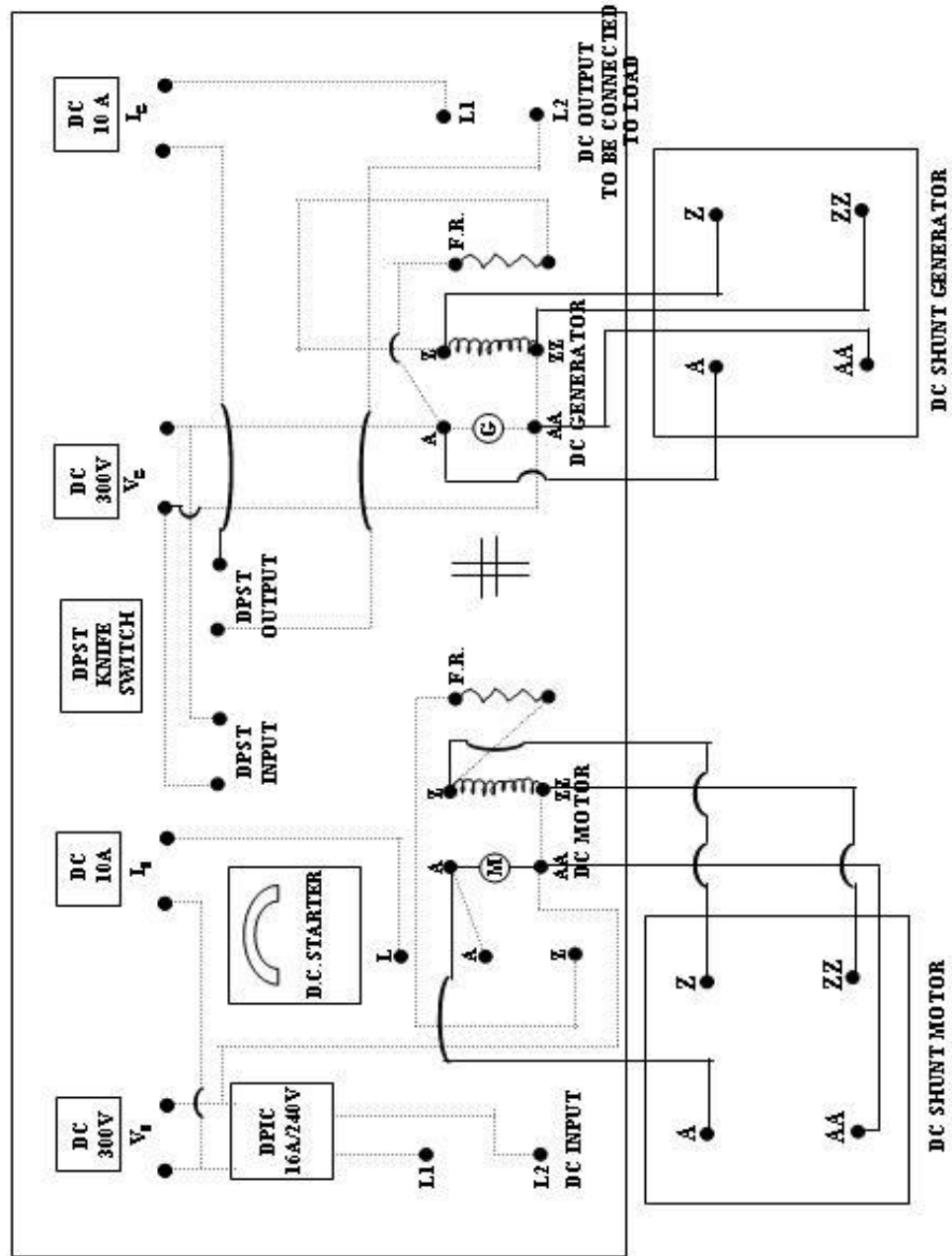## EXTERNAL CHARACTERISTICS OF DC SHUNT GENERATOR

For a shunt generator the external characteristics is obtained with constant resistance in the exciting circuit, the connections necessary for determining the characteristics experimentally. For the normal test the resistance in the field regulator is adjusted as that normal e m f is generated on open circuit and the resistance is not varied during the test which again is carried out at constant speed and with the machine at its usual working temperature.

With the shunt generator the fall that takes place in the terminal voltage when load is put on, is more marked then with the separately excited machine. The increased drop is due to the fact that a drop in the terminal voltage results in a fall in the value of the exciting current with a consequent fall in the value of the flux. When load is put on the shunt generator its voltage thus tends to fall by a process of exactly a reverse nature to that of "building up".
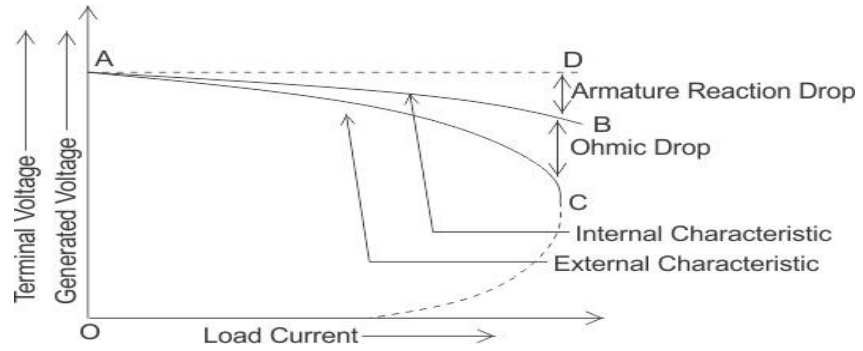
CIRCUIT DIAGRAM:

External characteristics of a DC Shunt Generator.
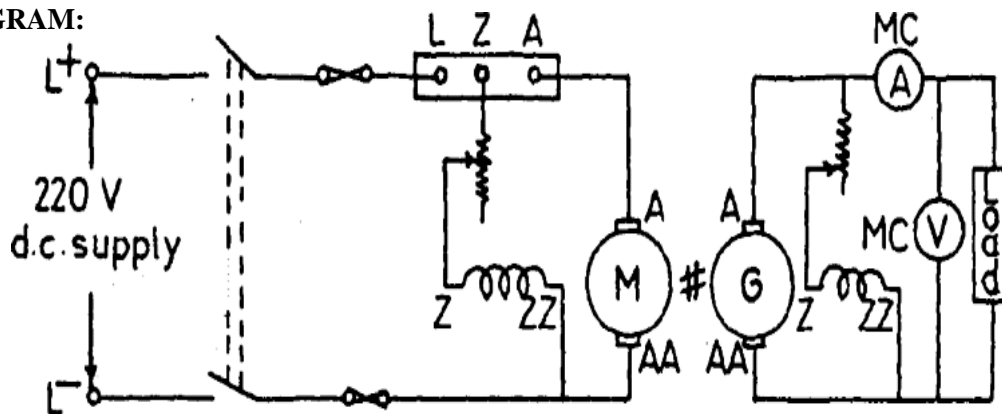
PANEL LAYOUT FOR LOAD CHARACTERISTICS OF DC SHUNT GENERATOR

OBSERVATIONS:

MOTOR		GENERATOR		
V_S	I_S	V_G	I_G	RPM

CALCULATION:

CONCLUSION: Draw plot between terminal voltage and load current (line current) for DC shunt G

LAB EXPERIMENT 3

AIM: To obtain load characteristics of a d.c. compound generator (a) Cumulatively compounded (b) Differentially compounded**.**

APPARATUS REQUIRED:

FOR DC MOTOR:-

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-10 A. – 1 No.

3. Tubular Rheostat 1.2 A. 260 Ohms – 1 No.

4. Indicating light

5. Educational type insulated terminals

6. DPIC Switch 16A, 240V.

7. DC Starter Point

FOR DC GENERATOR :

1. MC Voltmeter 96 x 96 mm flush mounted 0-300V – 1 No.

2. MC Ammeter 96 x 96 mm flush mounted 0-10 A. – 1 No.

3. Knife Blade Switch DPST -1 No.

4. Tubular Rheostat 1.2 A. 260 Ohms – 1 No.

5. Indicating light

6. Educational type insulated terminals

7. Lamp Bank Load suitable for above generator

PRIME MOVER: D. C. Shunt wound. 220/230V. 1500 RPM.

DC GENERATOR   :   Self excited – Compound 230V, 1500 RPM.

THEORY

The terminal voltage drop of the DC shunt generator with load makes this type of DC shunt generator undesirable where constancy of voltage is necessary. A substantial constant voltage in the terminal may be achieved when both the series and shunt field coil are present. Shunt field winding acts as the main field and series field either helps or opposes this shunt field. When both the fields help each other, the generator called cumulative compound type generator and oppose each other it is called differential compound type generator.
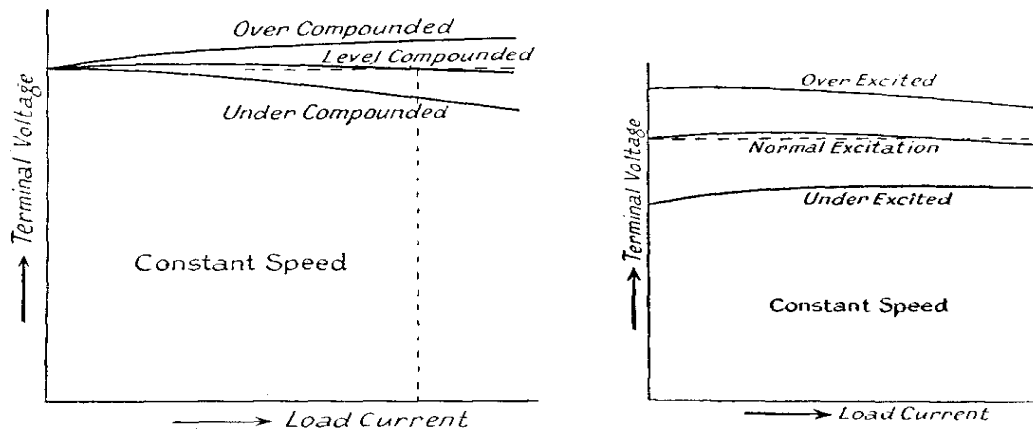
External characteristics of a DC Compound Generator.

CIRCUIT DIAGRAM:
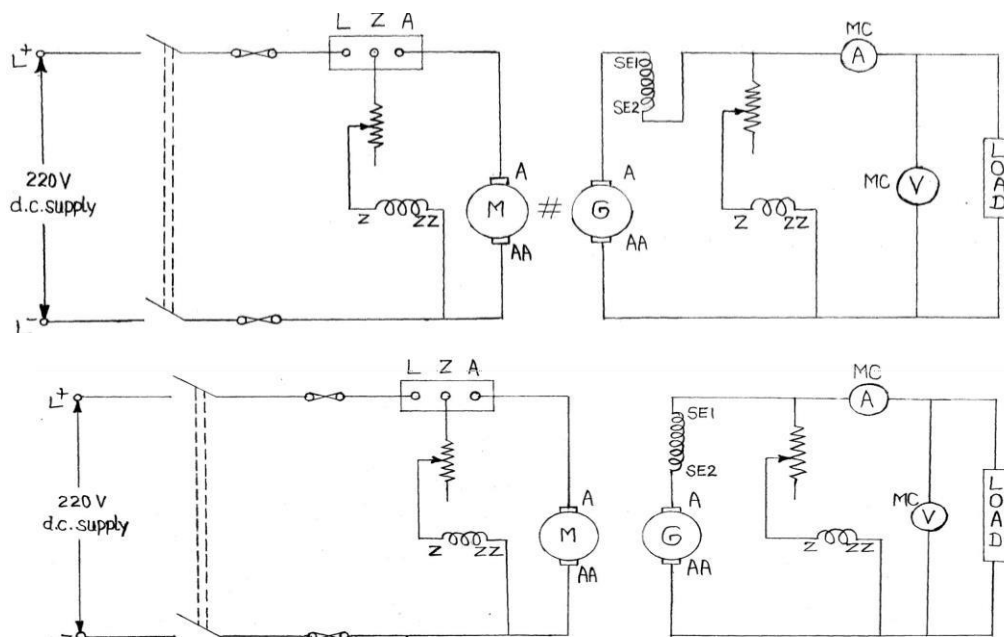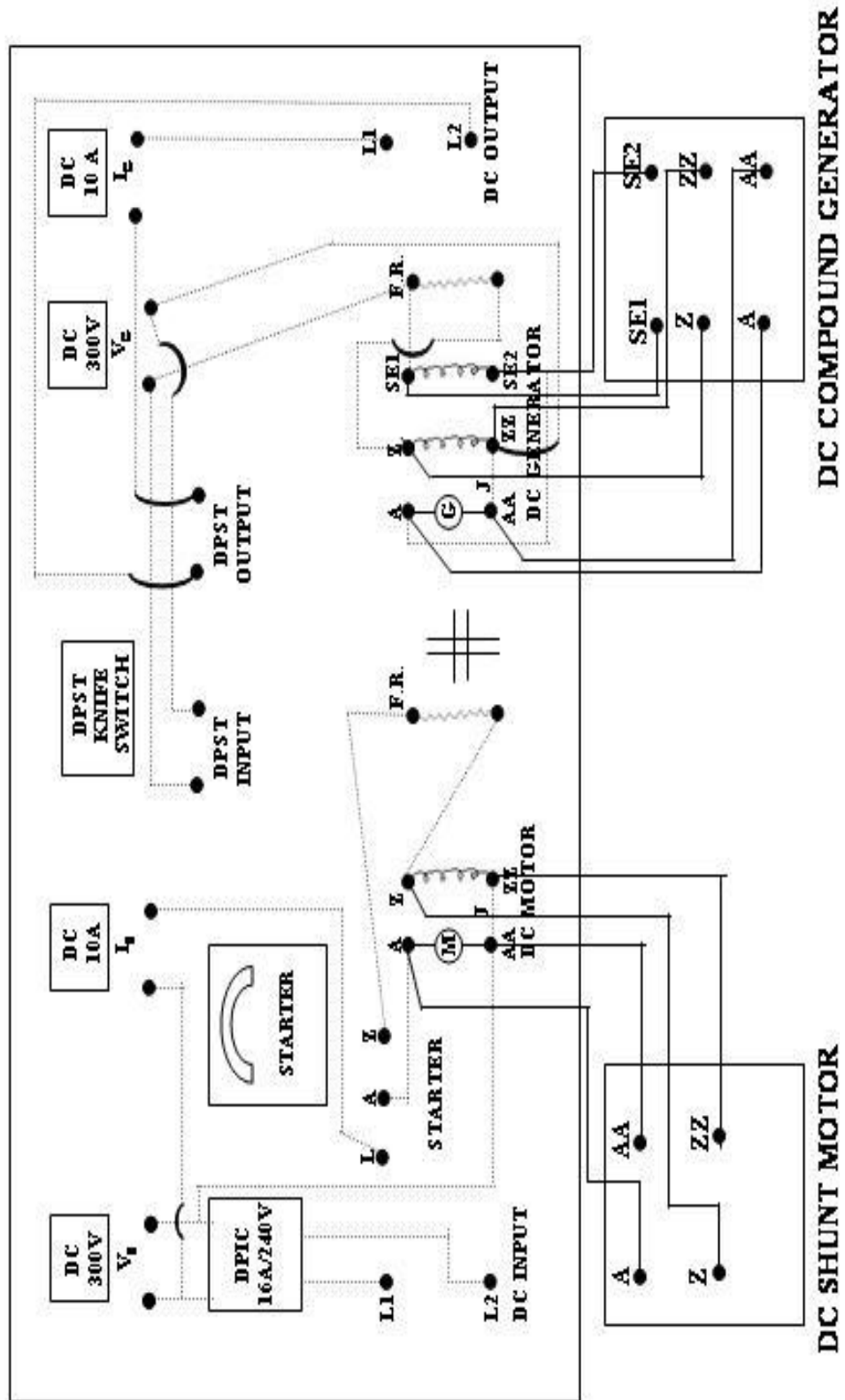
PANEL FOR LOAD CHARACTERISTICS OF DC COMPOUND GENERATOR

Fig 1: Load test on DC generator.

PROCEDURE:

9. Connect the circuit of motor and generator as per Fig 1 .

10. Set the rheostat, so that there is not external resistance in the field circuit of the motor.

11. Set the rheostat, so that there is maximum external resistance in the field circuit of the generator.

12. Switch on the supply to the DC motor and start it with the help of starter. Starter arm should be moved slowly, till the motor builds up its speed.

13. Adjust the speed of the motor to rated value by varying the resistance in the field circuit of the motor. Adjust the field current of generator by rheostat R_2, so as to obtain rated voltage at no load.

14. Switch on the lamp bank load and adjust a certain value of load current, say approximately 10 percent of full load current.

7 Record the load and the terminal voltage.

8. Repeat step 7 by various values of load current, till the full load current of the generator. Switch off the load on the generator.

9. To stop the DC motor, switch off the DC supply.

OBSERVATIONS:

MOTOR		GENERATOR		
V_S	I_S	V_G	I_G	RPM

CALCULATION:

CONCLUSION: Draw plot between terminal voltage and load current (line current) for DC Generator (a) Cumulatively compounded (b) Differentially compounded.

LAB EXPERIMENT 4

AIM: To obtain efficiency of a dc shunt machine using Swinburn's test.
To perform Swinburne's test on the DC machine, running as SHUNT MOTOR at NO-LOAD

APPARATUS USED:

DC Motor:
Type: SPDP (Screen Protected)
Capacity: 3 HP, 230V, 11 Amp, 1500 RPM.
Insulation: Class 'B'

INSTRUMENTS REQUIRED ON CONTROL PANEL FOR PERFORMING ABOVE EXPERIMENT:

1	MC Voltmeter 96 x 96 mm flush mounted 0-300V	– 1 No.
2	MC Voltmeter 96 x 96 mm flush mounted 0-30V	– 1 No.
3	MC Ammeter 96 x 96 mm flush mounted 0-10 A.	– 2 No.
4	MC Ammeter 96 x 96 mm flush mounted 0-1 Amp,	– 1 No.
5	Tubular Rheostat 1.1A, 330 Ohms – 1 No. (for field control)	
6	Indicating light	
7	Lamp bank load (for armature resistance calculation)	
8	Educational type insulated terminals	
9	DPIC Switch 16A, 240V, HAVELL'S make.	
10	DC Starter face plate type suitable for above motor.	

THEORY:

Swinburne's test is an indirect method (without loading) for finding out the efficiency of DC machine. Various losses occurring in a DC machine can be classified as (i) constant losses and (ii) variable losses. Variable losses are directly proportional to the square of armature current or approximately the load current, where as constant losses are independent of load conditions.

In this method, constant losses are determined experimentally by operating the DC machine as motor running at no load. Variable losses occurring on load are calculated from the known specifications of the machine.

Let the voltage applied to the shunt motor be V volts and the current flowing in the armature and shunt field circuit under no load running be I_{ao} and I_{sh} respectively. Then,

Input power to the armature circuit = V x I_{ao} watts Input

power to the shunt field circuit = V x I_{sh} watts

Total input power to the motor at no load, W0 = V x (I_{ao} + I_{sh})

Armature copper losses at no load = $I^2_{ao}R_a$

Thus, the constant losses of the machine, $W_c = W_o - I^2_{ao} R_a$ Watts

Hence, the constant losses of DC machine can be determined experimentally by recording I_{ao}, I_{sh}, V and measuring the armature resistance R_a.

The Swinburne's test should be performed at rated voltage and at rated speed.

CIRCUIT DIAGRAM:

Fig 'A' shows the circuit diagram for conducting Swinburne's test and for measuring the armature resistance respectively.
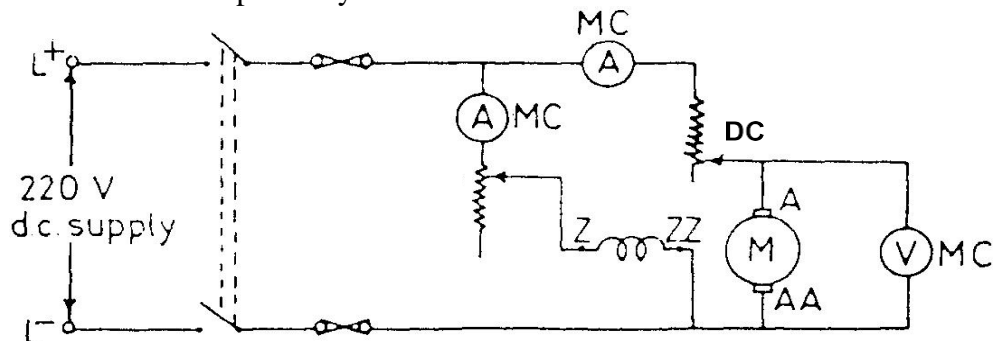

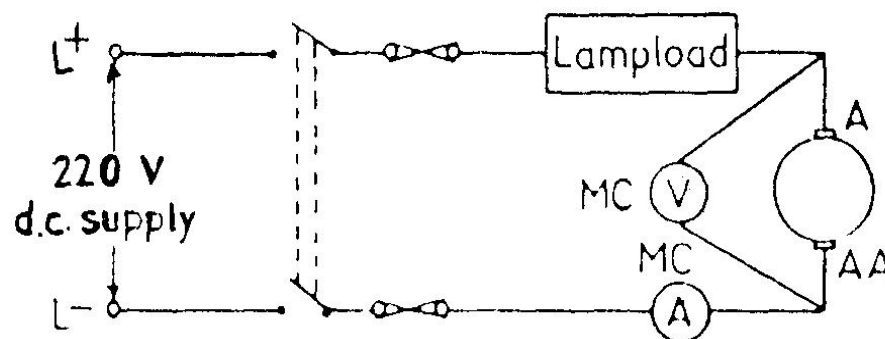Fig 'A' (i) : Sc hematic Diagram for Swinburne's test on DC Motor.

Fig 'A' (ii) : Schematic diagram for Measurement of armature resistanc

PROCEDURE:

(a) For conducting Swinburne's test

1. Connect the motor with control panel.

2. Ensure that the external resistance in field circuit is zero.
3. Switch ON the DC supply to the motor and start it with the help of starter. Move the handle arm of the starter by few steps till the motor builds up its speed. Ensure that the voltage applied to the motor is of rated value.

4. Record the reading of all the meters connected in the circuit.

5. To stop the motor, switch off the DC supply

(b) For measurement of armature resistance

1. Connect the measuring instruments externally meant for armature resistance calculation.
2. Put the DPST knife switch and DP switch in ON position. Switch on some bulbs in the lamp bank load, so that the current flowing in the armature circuit is the rated full load current of the DC motor, wait for few minutes with the full load current flowing in the armature winding, so that the temperature of the armature winding approximately becomes equivalent to that obtained under working conditions.

3. Record the reading of both the meters connected in this circuit.

4. Switch off the DC supply.

OBSERVATIONS:

For Swinburne's test				For armature resistance			
S No.	V	I_{ao}	I_{sh}	S No.	V_a	I_a	R_a

CALCULATION OF EFFICIENCY AS A SHUNT MOTOR

Efficiency $\eta = \dfrac{VI_L - P_L}{VI_L} * 100$

Where V= Motor rated voltage, I_L= load current, P_L= Total Loss Constant Loss and variable Loss

CONCLUSION:

LAB EXPERIMENT 5

AIM: To perform Hopkinson's test and determine losses and efficiency of DC machine

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-1)A	MC	1
		(0-20) A	MC	2
2	Voltmeter	(0-300) V	MC	1
		(0-600)V	MC	1
3	Rheostats	1250Λ, 0.8A	Wire Wound	2
4	Tachometer	(0-3000) rpm	Digital	1
5	Resistive Load	5KW,230V	-	1
6	Connecting Wires	2.5sq.mm.	Copper	Few

Theory: Hopkinson's test is a regenerative test in which two identical DC shunt machines are coupled mechanically and tested simultaneously. One of the machines is made to act as a motor driving the other as a generator which supply electric power to the motor. The set therefore draws only loss power from the mains while the individual machines can be fully loaded.

CIRCUT DIAGRAM:
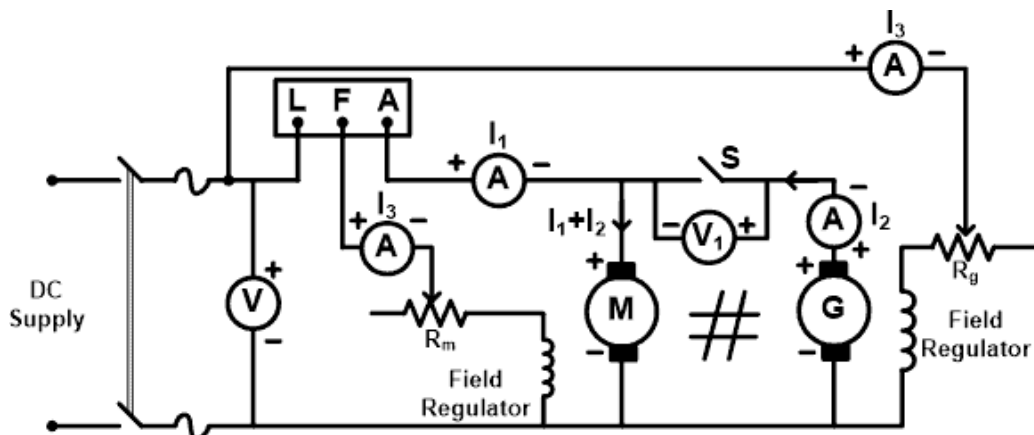
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the minimum position of field rheostat of motor
3. maximum position of field rheostat of generator, opening of SPST switch, DPST switch is closed and starting resistance is gradually removed.
4. The motor is brought to its rated speed by adjusting the field rheostat of the motor.
5. The voltmeter V_1 is made to read zero by adjusting field rheostat of generator and SPST switch is closed.
6. By adjusting field rheostats of motor and generator, various Ammeter readings, voltmeter readings are noted.
7. The rheostats and SPST switch are brought to their original positions and DPST switch is opened.

OBSERVATIONS:

Sr. No.	V	I_1	I_2	I_3	Copper Loss	Field Loss	Stray Loss	Total Loss

CALCULATION:

CONCLUSION:

LAB EXPERIMENT 6

AIM: To Obtain Speed-Torque Characteristics of a DC Shunt Motor

APPARATUS REQUIRED:

S.No.	Apparatus	Type	Range	Quantity
1	Ammeters	PMMC	0-15Amp	1
2	Voltmeter	PMMC	0-300V	1
3	DC Shunt Motor	SPDT (Screen Protected)	-	1
4	Field Regulating Rheostat	-	-	1
5	DC Motor Starter	Three Point	-	1
6	Loading Arrangement	Mechanical	-	1
7	Spring Balance	Longitudinal	50 Kg Each	2

Theory: The Load test on DC Motor is performed to obtain its various performance characteristics including efficiency. The motor can be loaded by a belt and pulley. If S1, S2 be tensions in kilograms provided on the two sides of the belts, then the load torque on motor is given by-
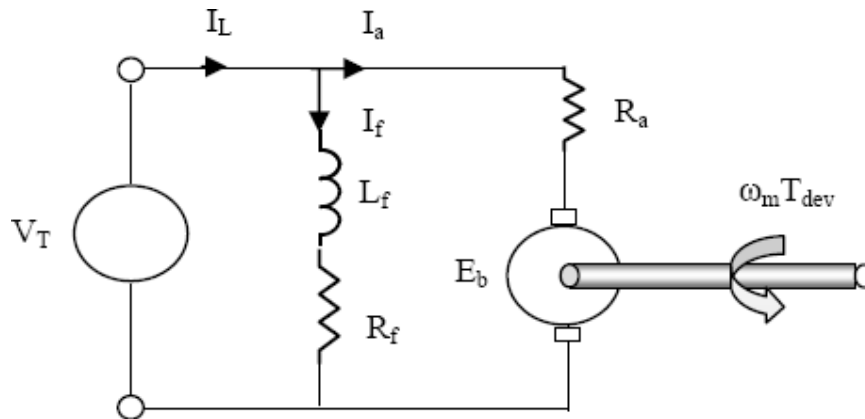
Load Torque Tl   =   (S1 – S2) x   R Kg-m

Where

R   -   Radius of Pulley

S1, S2-Two weights on the belts.

CIRCUT DIAGRAM:

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the minimum position of field rheostat of motor, maximum position of field rheostat of generator, opening of SPST switch, DPST switch is closed and starting resistance is gradually removed.
3. The motor is brought to its rated speed by adjusting the field rheostat of the motor.
4. Motor is loaded by tightening the spring load.
5. Spring balance reading S_1 and S_2 is noted.
6. Calculate the torque from above mentioned formula.

OBSERVATIONS:

Sr. No.	Speed, N	S_1	S_2	T

CALCULATION

CONCLUSION:

The graph between speed of the motor in RPM and torque in Kg-m has been plotted. During the experiment as we go on increasing the load by changing the weight The speed of DC Motor goes on decreasing. This is because of larger torque, larger armature current is required & this has the effect or reducing the gap flux.

LAB EXPERIMENT 7

AIM: **TO STUDY SPEED CONTROL OF A DC SHUNT MOTOR USING**

(I) Field Current

(II) Armature Current

APPARATUS REQUIRED:

Serial No.	Equipment	Specification	Quantity
1	DC shunt motor	250V, 2kW	1
2	PMMC ammeter	0 –10A	2
3	Rheostats		2
3	Tachometer		1
4	3-point starter		1
5	DPIC switch		1
6	Connecting Leads		

THEORY:

We know that, in DC Shunt motor, the back emf is given by

$$E_b = V - I_a R_a = \frac{\phi ZNP}{60A}$$

So Speed

$$N = (V - I_a R_a) / Z\Phi P \times 60A \qquad\qquad (1)$$

$N \propto 1/\Phi$ and $N \propto 1/R_a$ (N is speed in RPM)

Where Φ is flux per pole & Ra is armature

resistance

*(a) **Field Control Method:***

This method is applied, where we have to obtain the speed greater than normal rated speed. If we insert a resistance in field winding, field current becomes less, consequently flux also becomes less & speed increases.

Armature Control Method:

If we need the speed less than the rated speed, we use this method. When we insert a resistance in the series of armature, IaRa will increase; therefore, the speed of shunt motor reduces by the equation (1).
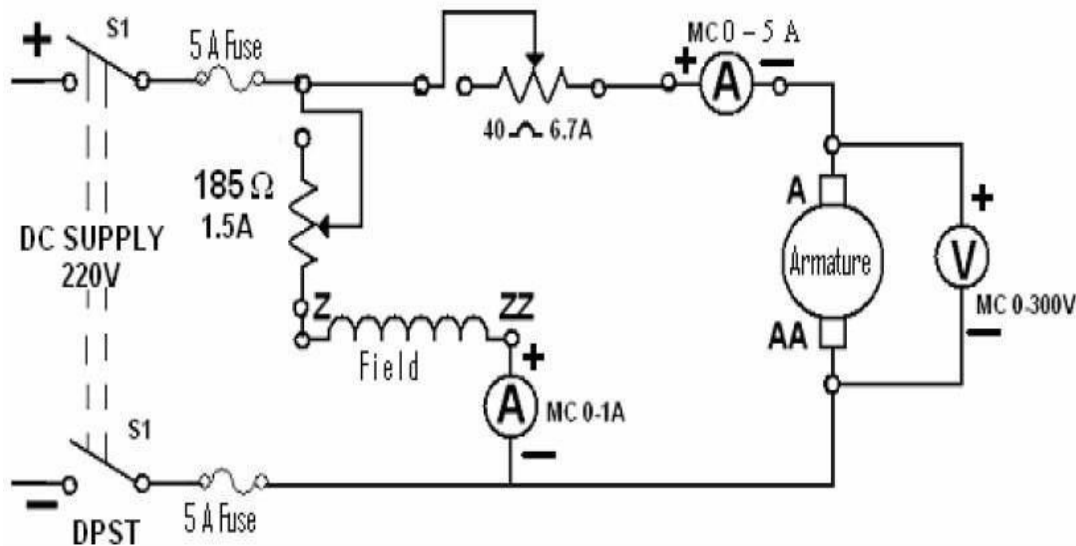
PROCEDURE:

1. Connect the circuit as shown in circuit diagram.
2. Start the motor with maximum resistance in the armature circuit and minimum resistance in the field circuit.
3. Bring the motor to the rated speed, first by decreasing the resistance in thearmature circuit and then by increasing the resistance in the field circuit.
4. Vary the resistance in the field circuit and take readings of speed and field current,keeping the armature voltage constant at a particular value.
5. Change armature voltage to another value and repeat the procedure given in – (iv)
6. Then change the resistance in the armature circuit and take reading of speed and armature voltage, keeping the field current constant at a particular value.
7. Change the field current to another value, repeat the procedure given in (vi).
8. Take three sets of readings for each method of variation.

OBSERVATION TABLE:

Table I: Variation of speed with field excitation.

Sl. No.	Field current(A)	Speed(rpm)	Constant Armature Voltage (V)

Table II : Variation of speed with armature voltage.

Sl. No.	Armature voltage (V)	Speed(rpm)	Constant field Current (A)

CALCULATION:

CONCLUSION

1. With the increase in resistance in the field circuit, the field current decreases so speed increases.
2. With the increase in resistance in the armature circuit, voltage drop in armature increases
   i.e. back emf E_b decreases and, therefore, speed decreases.
3. Plot speed against field current for different sets of constant armature voltage on a graph paper.
4. Plot speed against armature voltage for different sets of constant field current on another graph pap

LAB EXPERIMENT 8

AIM To Obtain Equivalent Circuit, Efficiency And Voltage Regulation of A Single- Phase Transformer Using O.C. And S.C. Tests.

APPARATUS REQUIRED:

Serial No.	Equipment	Specification	Quantity
1	Single-phase transformer		
2	MI voltmeter	0-300V	
3	MI ammeter	0-5 A	1
4	Dynamometer Type wattmeter	5 A,240 V	1
5	Auto-transformer or Variac	0- 300 V	1
6	Connecting leads		

THEORY:

Transformer is a high efficiency, static machine. It transfers the power from one circuit to other circuit at same frequency. The efficiency of small rating transformer can be found by directly loading method, but in case of large transformer, it cannot. Because it is impossible to full load the large transformers in laboratory and it is also costly. So we perform the opencircuit test & short circuit test on a transformer to measure its losses by which we can calculate efficiency and voltages regulation of the transformer.

Open Circuit Test:

This test performed to find out the no load losses (iron losses) and no load current. Since, atthe no load condition or open circuit secondary condition, load current in primary is very less, so copper losses can be neglected.

In this test, primary winding (generally LV side) energized with rated voltage & secondary winding (HV Side) is open circuited. The connected apparatus i.e. voltmeter, ammeter and

wattmeter, in primary side measures, voltage across primary terminals, no load current and no load losses respectively.
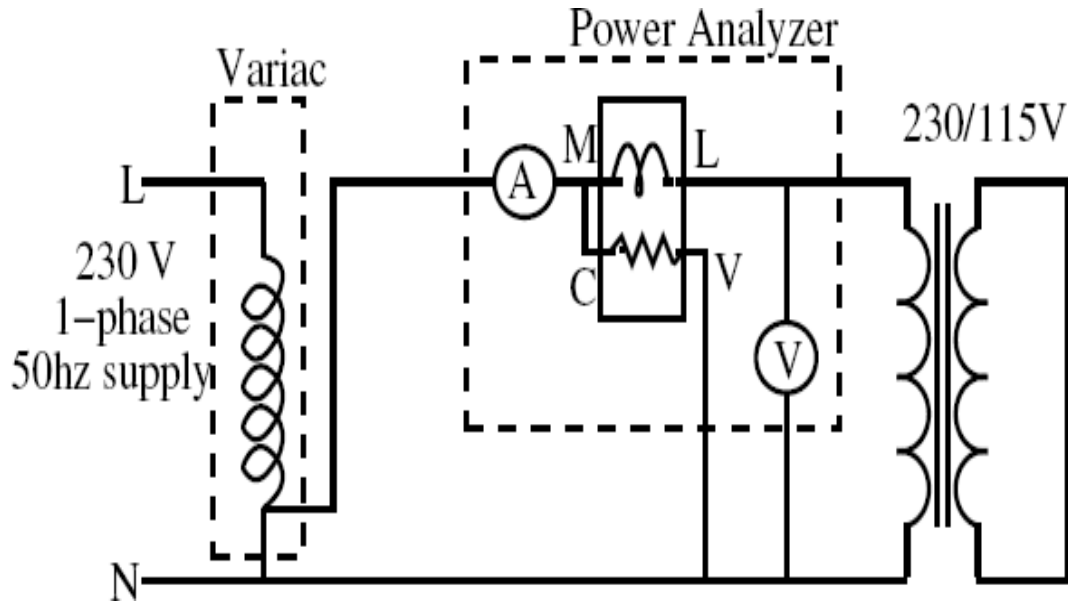
Short Circuit Test:

The main purpose of this test is to find out the copper losses. This test is performed by keeping LV winding short circuited with a wire or ammeter and energized HV side with its full load current. Since, this full load current is started flowing at the low voltage (generally 5 to 10% of rated voltage), so less magnetic flux produced; due to this reason core losses or iron losses can be neglected. The apparatus i.e. ammeter, voltmeter & wattmeter connected in HV side, measures the full load current, short circuit voltage and full load copper losses respectively.

    i.   **CIRCUIT DIAGRAM: Open Circuit Test:**
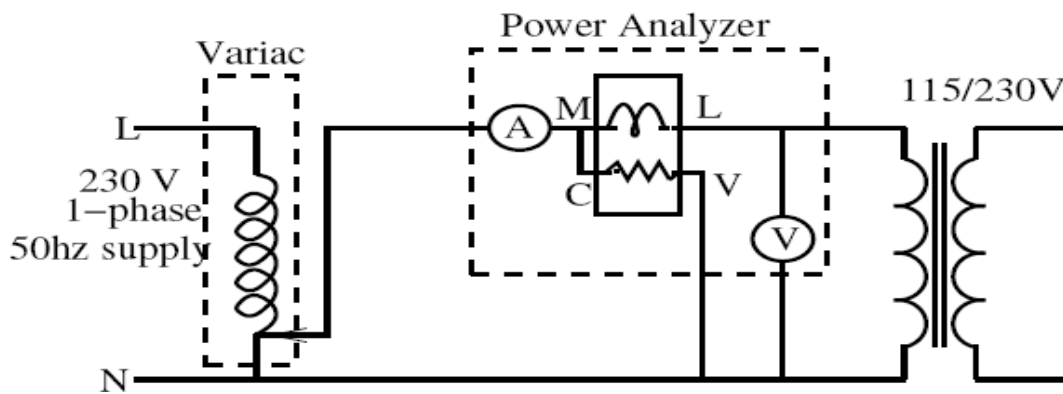
    i.   **Short Circuit Test:**

PROCEDURE:

Open Circuit Test:

1. Connect all the apparatus as the circuit diagram.

2. ON the switch of power supply and adjust rated voltage across L.V. Side.

3. Record No-load current, voltage applied and no load power factor of the transformer winding in observation table.

4. Switch OFF the supply after recording the readings.

Short Circuit Test:

1. Connect all the apparatus and instruments according to circuit diagram.

2. Adjust the variac at zero.

3. ON the switch of power ac supply.

4. Increase the applied voltage slowly, till the full load current in corresponding winding.

5. Note down the ammeter, voltmeter and wattmeter readings in the observation table.

6. Switch off the supply after taking the reading

OBSERVATION TABLE:

	Open Circuit Test	Short Circuit Test

S.No.	Input voltage (V1) volts	No-Load Current (Io)	Iron losses (Wo)	Short Circuit Volatge (Vsc) Volts	Full laod Current (Isc) Amps.	Cu-Losses (Wsc) watts or Psc.

CALCULATIONS:

For OC Test:

Iron Loss, $P_i = W_0$ Watts

No – load current $= I_0$ amperes

$$\cos\phi_0 = \frac{W_0}{V_1 I_0}$$

Loss component of current, $I_e = I_0 \cos\phi_0 = \dfrac{W_0}{V_1}$

Magnetizing component of current, $I_m = \sqrt{I_0^2 - I_e^2}$

Equivalent circuit Parameter, $R_0 = \dfrac{V_1}{I_e} = \dfrac{V_1^2}{W_0}$

Equivalent circuit Parameter, $X_0 = \dfrac{V_1}{I} = \dfrac{V_1}{\sqrt{I_0^2 - I_e^2}}$

SC Test:

$$P_c = I_{sc}^{\ 2} R_{eq} = W_{sc}$$

Full load copper loss,

Equivalent resistance , $R_{eq} = \dfrac{W_{sc}}{I_{sc}^{\ 2}}$

Equivalent impedance, $Z_{eq} = \dfrac{V_{sc}}{I}$

$$\sqrt{Z_{eq}^{\ 2} - R_{eq}^{\ 2}}$$

Equivalent reactance

CONCLUSION: Iron loss is given by open circuit test and copper loss is given by short circuit test

LAB EXPERIMENT 9

AIM: To s study Speed control of slipring Induction Motor

https://ems-iitr.vlabs.ac.in/exp/speed-control-slip-ring

LAB EXPERIMENT   10

AIM: To perform speed control of DC motor by using Ward-Leonard Method of speed control
.

 https://ems- https://ems-iitr.vlabs.ac.in/exp/dcmotor-ward-leonard

This lab manual has been updated by

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Please spare some time to provide your valuable feedback.