LABORATORY MANUAL

of

ELECTRICAL MACHINE-I LABORATORY (R22A0282)

II B. Tech I – SEM (EEE)

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MALLA REDDY COLLEGE ENGINEERING & TECHNOLOGY
(Autonomous Institution – UGC, Govt. of India)
(Affiliated to JNTU, Hyderabad, Approved by AICTE - - ISO 9001:2015 Certified)
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NIRF India Ranking 2018, Accepted by MHRD, Govt. of India.

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CERTIFICATE

Department of Electrical and Electronics Engineering certified that in the bonafide Record of the work done by Mr./Miss.---

Reg.No------------------------of B-Tech EEE --------YEAR-----------semester for the Academic year 20---------to 20---------- in --------------------------Laboratory.

Date: **Staff In charge** **HOD**

LIST OF EXPERIMENTS

INTRODUCTION TO TEST PROCEDURE WITH COMPUTER SETUP:

- The machines laboratory is setup with the following new features.
  - The motors are controlled using a static electronic power drive unlike the conventional method of using 3-point starters and DC output power.
  - Further, the motors can be controlled either manually by directly using the electronic drive unit or through PLC/Micro controller unit(Data logger)
- Hence the general procedure for all experiments is given in both methods.
- First, the power is extended to the test bench by switching on the corresponding MCB in the mains panel. Then the test panel is energized by switching on the MCB on the panel (Before switching on the local MCB it is to be confirmed that the drive control pot meter is in minimum position).
- The computer is switched on and ***DIAVIEW*** software is executed from the desktop.
- The computer now displays either the SCADA display (in case of PLC controlled set ups) and Data logger display (in case of data logger/micro controller setup)

MANUAL MODE:

1. METHOD OF STARTING THE MOTOR:

- The field rheostat is kept in minimum resistance position.
- Then the pot meter is rotated in clock wise gradually thus increasing the speed.
- In maximum position of the pot meter, motor is expected to reach slightly lesser than its rated speed.
- Now the field is weakened by increasing the field rheostat and the speed is brought to the rated speed as required for the respective test setup.

2. DATA READ OUT/RECORDING PROCEDURES:

- Depending upon the test setup all the relevant data like voltages, currents, speed and force are read out from the respective panel meters and noted down.
- Even in the manual mode of control the same data whatever is available on the panel meters can also be seen on the computer mimic diagram if the computer and PLC/Micro controller are kept in ON condition.
- This data at the end of the experiment can also be exported to the system memory with the required student information for further analysis and records.

PLC/MICRO CONTROLLER MODE:

1. METHOD OF STARTING THE MOTOR:

- The field rheostat is kept in minimum resistance position.
- Then using the mouse and the curser,
  - PLC/CONTROLLER mode is selected from mimic diagram.
  - Then motor start button is pressed
  - Speed is increased gradually by increasing the drive output voltage till the rated armature voltage is reached as read by the respected panel meter and the computer display.
- Now the field is weakened by increasing the field rheostat and the speed is brought to the rated speed as required for the respective test setup.

2. DATA READ OUT/RECORDIND PROCEDURES:

- Depending upon the test setup all the relevant data like voltages, currents, speed and force are read out are available on the mimic display
- The data at required instant of the experiment is logged by going to the data log in page and clicking on the data logger icon

- After collecting relevant experimental data in the ***DIAVIEW*** screen, the file is exported to system memory with the required student information for further analysis and records.

EXP.NO: 01

Date:

MAGNETIZATION CHARACTERISTICS OF DC SHUNT GENERATOR

AIM: To obtain magnetization characteristics of a DC shunt generator & to find its critical field resistance at constant rated speed and critical speed

NAME PLATE DETAILS:

Term	D .C Shunt Motor	D.C Shunt Generator
Power	5 H.P , 3.7KW	3KW
Voltage	220V	220V
Current	19A	19A
Speed	1500RPM	1500RPM
Field current	1A	1A

FUSE RATING:

Motor side:

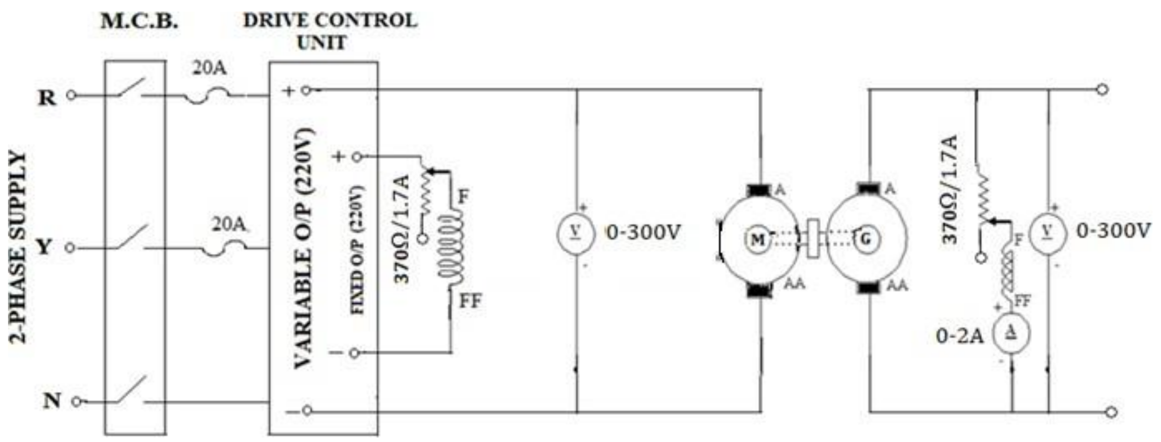
125% of rated current of DC Motor

125x19/100=23.75≈ 25 A

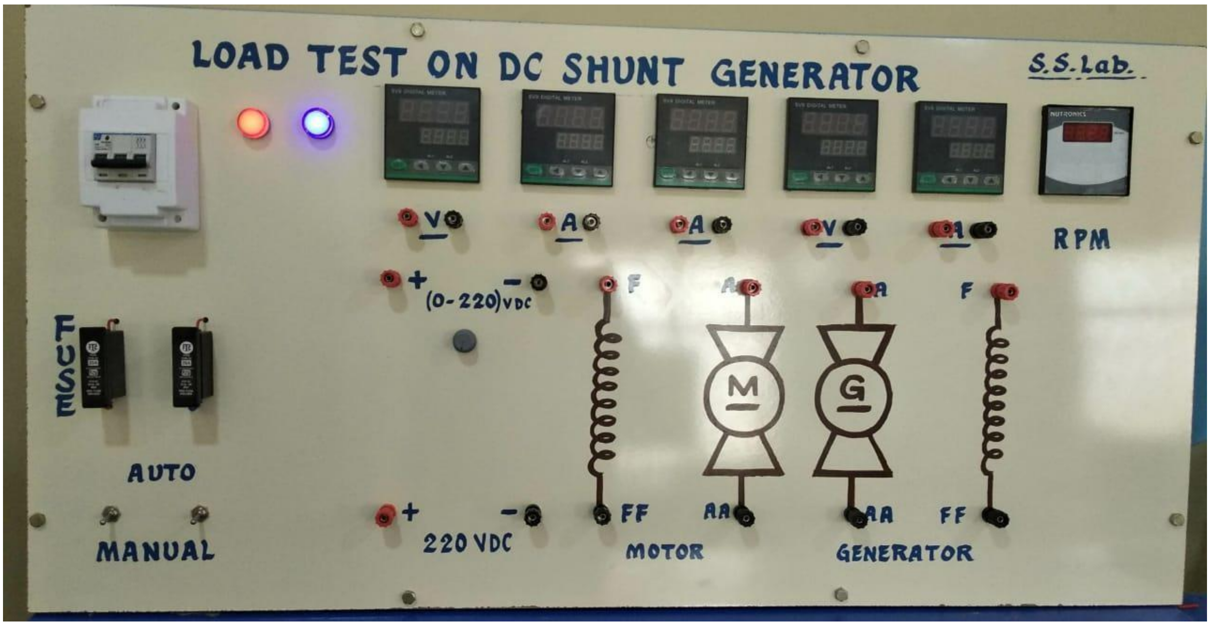
APPARATUS REQUIRED:

S. No	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-2)A	Digital	1	On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostats	370Ω,1.7A	Wire Wound	2	External
4	RPM meter	(0-9999)rpm	Digital	1	On Panel
5	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM:



PANEL:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Before starting the motor, ensure that both field rheostat and Pot meter of Drive Control Unit are in minimum position and the field rheostat of Generator should be in its maximum position. Similarly the load resistance connected to the Generator should be in its minimum position (No load).
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.

4. Now by adjusting the field rheostat, the motor is brought to the rated speed.
5. Now the field Rheostat of generator is varied and the field resistance is gradually decreased in steps thus increasing the field current. At each step the field current (I_f) and the corresponding induced EMF (Eg) are recorded in the tabular column. This procedure is continued until the generator voltage reaches its rated value.

   Note: While conducting the experiment the machine is maintained at constant speed.
6. After the experiment is completed the various rheostats are brought back to their original position in sequence and then main supply is switched off**.**

PRECAUTIONS:

1. The field rheostat of motor should be in minimum resistance position at the time of starting to start the machine from minimum speed.
2. The field rheostat of generator should be in maximum resistance position at the time of starting and stopping the machine.
3. Residual voltage should be taken under no field current.
4. The characteristics should be drawn at constant rated speed by adjusting the drive unit or motor filed resistance as required.

OBSERVATIONS:

R_{sh} = ohms

Sl. No	**Field Current I_f (Amps)**	**Armature Voltage E_o (Volts)**
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

CRITICAL FIELD RESISTANCE:

It is that value of the field resistance at which the D.C. shunt generator will fail to excite.

Critical field resistance is obtained by plotting the OCC as in fig.1 and drawing a tangent to the linear position of the curve from the origin. Then critical resistance is given by the slope of that tangent. While drawing the tangent, the initial position of the O.C.C is neglected.

CRITICAL SPEED:

It is that speed for which the given shunt field resistance becomes the critical field resistance.

The shunt field resistance (R_{sh}) line is obtained by taking the point of intersection of the OCC at rated speed and the rated E_g line parallel to the I_f axis. The line joining the origin with this point of intersection is the (R_{sh}) line.

Then OCC's are obtained at reduced speeds by conducting the above experiment till the Rsh line (corresponding to rated speed and rated generated voltage)becomes tangential to the reduced speed OCC. That speed is called the critical speed. This is shown in fig.2,The lower speeds are obtained by reducing the controller unit pot meter (armature voltage control).

MODEL GRAPH:

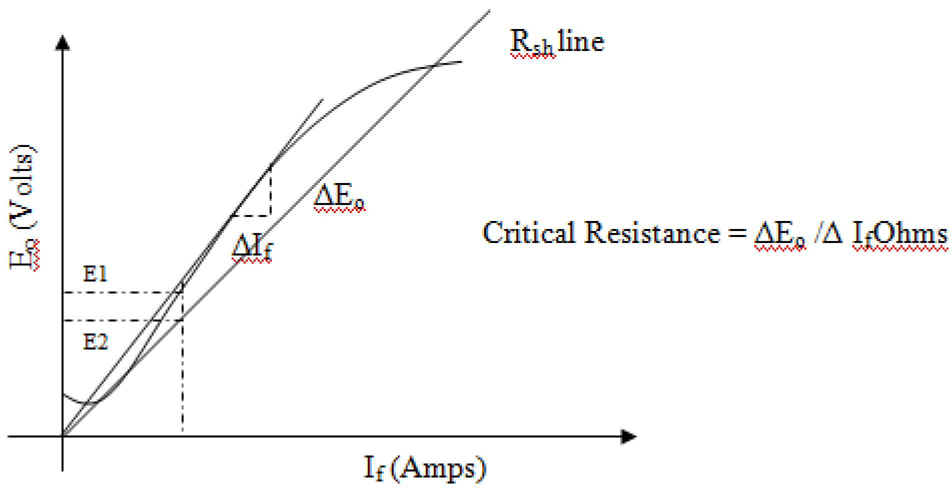


Fig.1

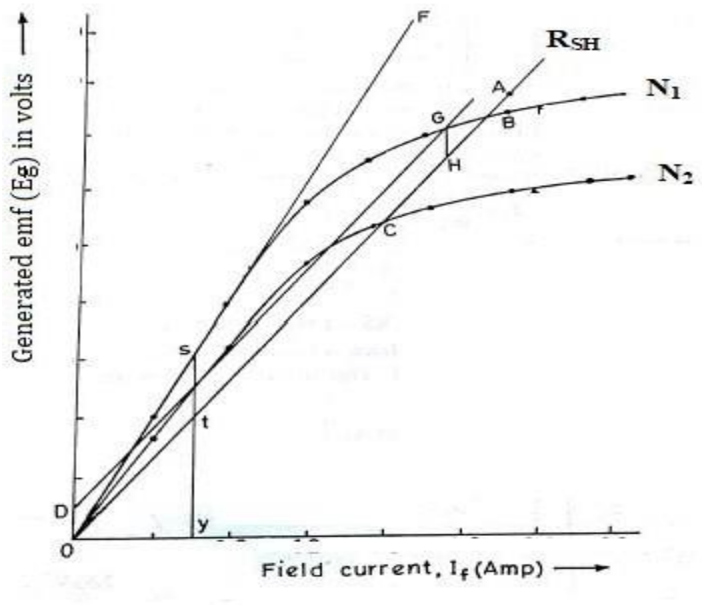


Fig.2

CALCULATIONS:

Critical resistance $R_c = \Delta E_0 / \Delta I_f$ = **ohms**

Critical speed $N_C = N_3 = N_1 \times \frac{}{VOLTAGE\ ys}$ **rpm**

DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. What is the principle of generator?
2. What is meant by residual magnetism?
3. What is critical field resistance?
4. What is meant by saturation?
5. What is the difference between a separately excited dc generator and shunt generator?
6. If a DC shunt generator fails to build up voltage, what may be the probable reasons?
7. What is SPST? What is its use in this experiment?
8. What is the reason for the presence of residual magnetism in the field poles?

RESULT:

EXP.NO: 02

Date:

LOAD TEST ON DC SHUNT GENERATOR

AIM: To obtain internal and external characteristics of DC shunt generator at constant rated speed.

NAME PLATE DETAILS:

Term	D .C Shunt Motor	D.C Shunt Generator
Power	5 H.P , 3.7KW	3KW
Voltage	220V	220V
Current	19A	19A
Speed	1500RPM	1500RPM
Field current	1A	1A

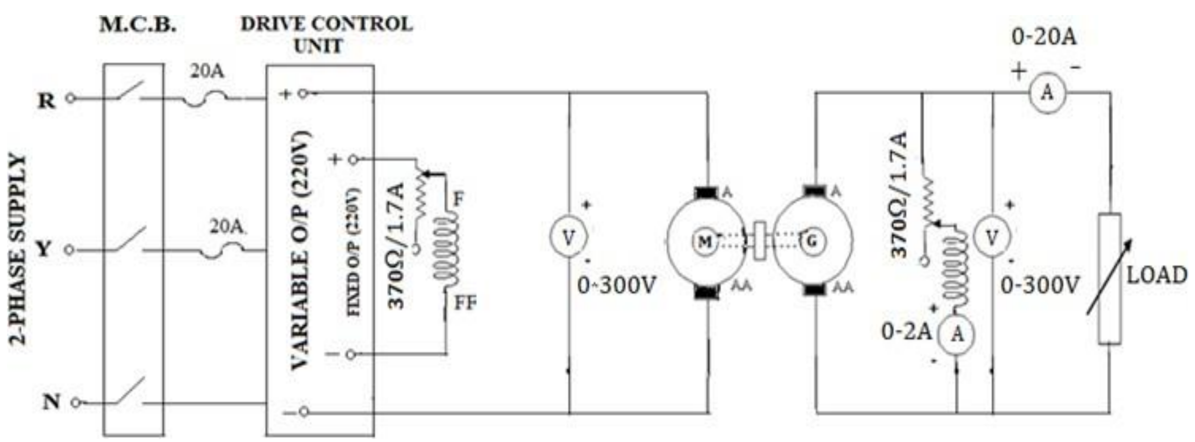
FUSE RATING

Motor and Generator side:
125% of rated current of DC Motor
125*19/100=23.75≈ 25 A

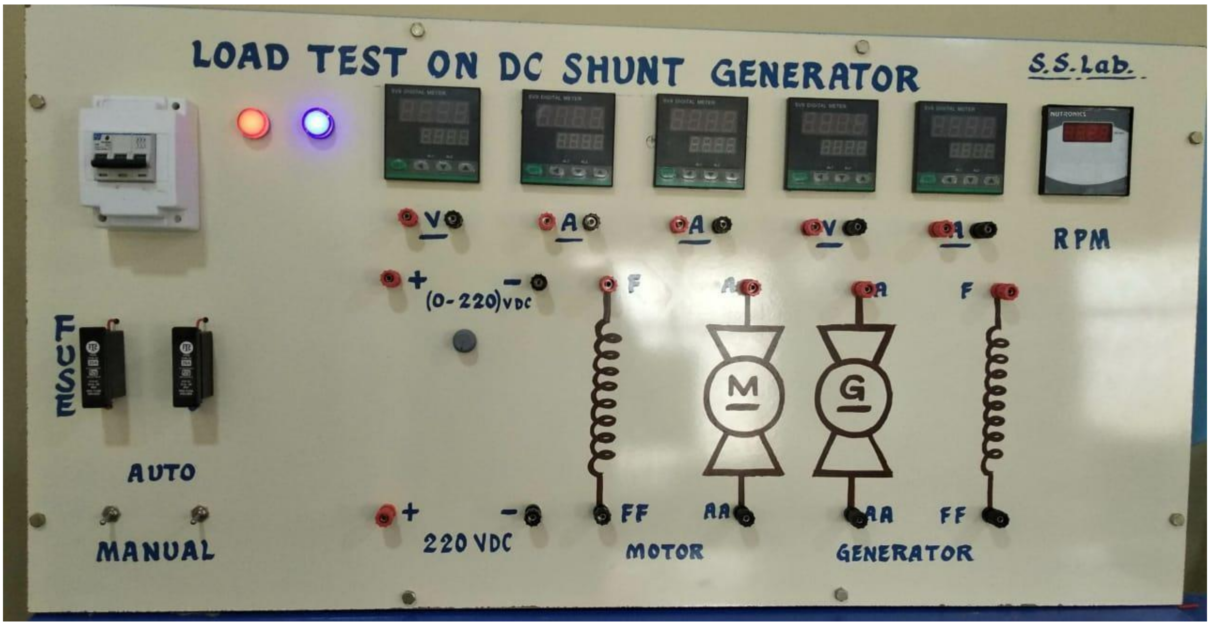
APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-2)A (0-20) A	Digital Digital	1 1	On Panel On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostats	370Ω/1.7A	Wire Wound	2	External
4	Resistive load bank	20A	-	1	External
5	RPM meter	(0-9999)rpm	Digital	1	On Panel
6	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM :



PANEL:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position and the field rheostat of Generator should be in its maximum position. Similarly the load resistance connected to the Generator should be in its minimum position (No load).
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.
4. By adjusting the motor field rheostat, the motor is brought to rated speed.
5. Then the generator field rheostat is adjusted until the generator voltage reaches its rated value. The terminal voltage and the field current are noted in the tabular column.
6. Now the load on the generator is gradually increased in steps. At each step the speed of the generator is checked and maintained constant at its rated value by adjusting the field rheostat of the motor. After satisfying this condition on each loading, the terminal voltage (V_L), field current (I_F) of Generator and the load current (I_L) are noted down in the tabular column.
7. Then the generator is unloaded and the field rheostat of DC shunt generator is brought to maximum position and the field rheostat of DC shunt motor to minimum position and MCB is opened.

PRECAUTIONS:

1. The field rheostat of motor should be at minimum position.
2. The field rheostat of generator should be at maximum position.
3. No load should be connected to generator at the time of starting and stopping

OBSERVATIONS:

Sl. No:	Field Current I_f (Amps)	Load Current I_L (Amps)	Terminal Voltage (V_L) Volts	$I_a = I_L + I_f$ (Amps)	$E_g = V + I_a R_a$ (Volts)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

FORMULAE & NOMENCLATURE:

$E_g = V + I_a R_a$ (Volts)

$I_a = I_L + I_f$ (Amps)

E_g: Generated emf in Volts

V: Terminal Voltage in Volts

I_a: Armature Current in Amps

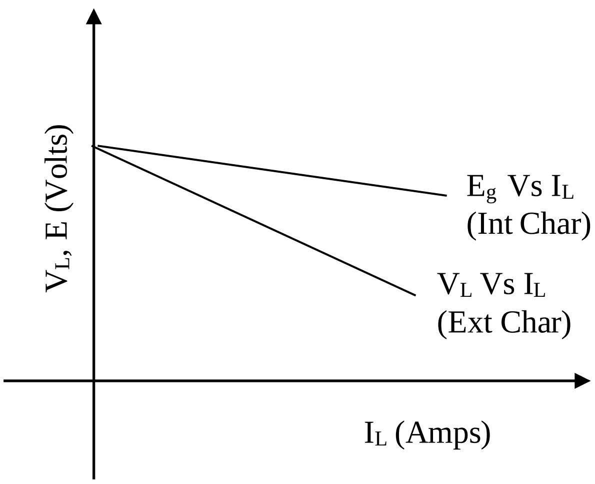
I_L: Line Current in Amps

I_f: Field Current in Amps

R_a: Armature Resistance in Ohms

CALCULATIONS:

MODEL GRAPH:



DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. What are the reasons for the drooping load characteristics?
2. Why does the terminal voltage decrease as the load current increases?
3. Why the load characteristics of dc shunt is having Drooping characteristics?
4. Why the Drooping of Dc Shunt Generator is more when compared to separately excited generator? (I_f independent of voltage.)
5. How can the external characteristics be drawn?
6. How can the internal characteristics be drawn from External characteristics?
7. What are the applications of shunt generator?
8. Shunt field winding of a dc machine consists of
    a. Many turns of thin wire
    b. Few turns of thick wire

RESULT:

EXP.NO: 03

Date:

LOAD TEST ON DC SERIES GENERATOR

AIM: To obtain internal and external characteristics of DC series generator

NAME PLATE DETAILS:

Term	D .C Shunt Motor	D.C Series Generator
Power	5 H.P , 3.7KW	3KW
Voltage	220V	220V
Current	19A	19A
Speed	1500RPM	1500RPM
Field current	1A	-

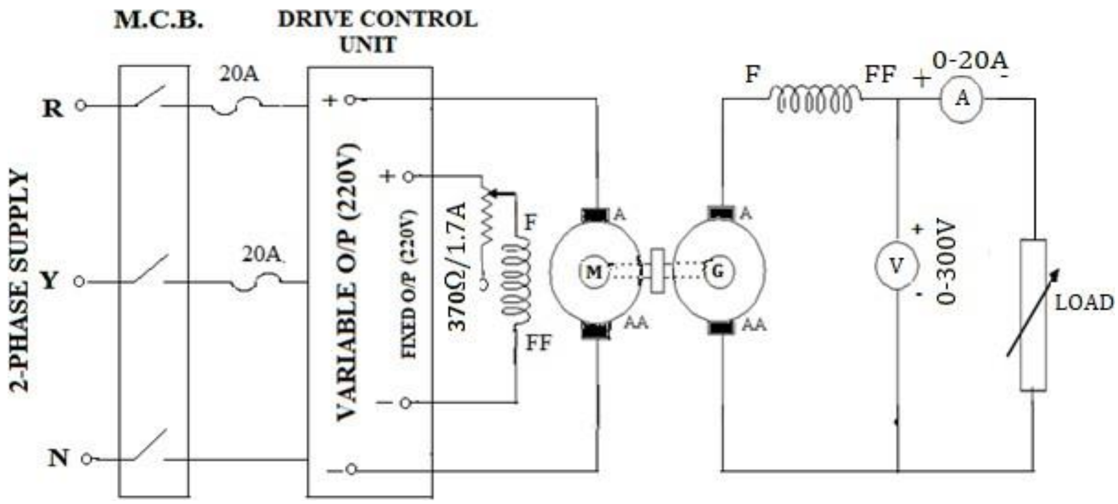
FUSE RATING

Motor and Generator side:
125% of rated current of DC Motor
125*19/100=23.75≈ 25 A

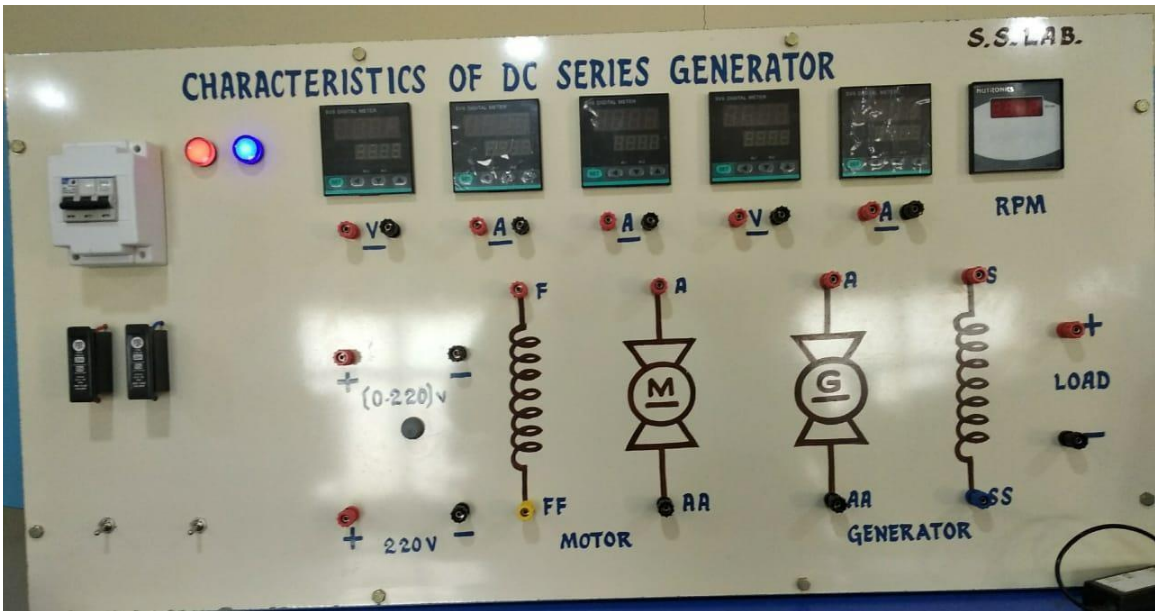
APPARATUS REQUIRED:

S. No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-20) A	Digital	1	On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostats	370Ω/1.7A	Wire Wound	1	External
4	Resistive load bank	20A	-	1	External
5	RPM meter	(0-9999)rpm	Digital	1	On Panel
6	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM:



PANEL:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position and the field rheostat of Generator should be in its maximum position. Similarly the load resistance connected to the Generator should be in its minimum position (No load).
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.

4. By adjusting the motor field rheostat, the motor is brought to rated speed.
5. Under no load condition, Ammeter and Voltmeter readings are noted.
6. Now the load on the generator is gradually increased in steps. At each step the speed of the generator is checked and maintained constant at its rated value by adjusting the field rheostat of the motor. After satisfying this condition on each loading, the terminal voltage (V_L) and the load current (I_L) are noted down in the tabular column.
7. Then the generator is unloaded and the field rheostat of DC shunt motor is brought to minimum position and MCB is opened.

PRECAUTIONS:

1. The field rheostat of motor should be at minimum position.
2. No load should be connected to generator at the time of starting and stopping.

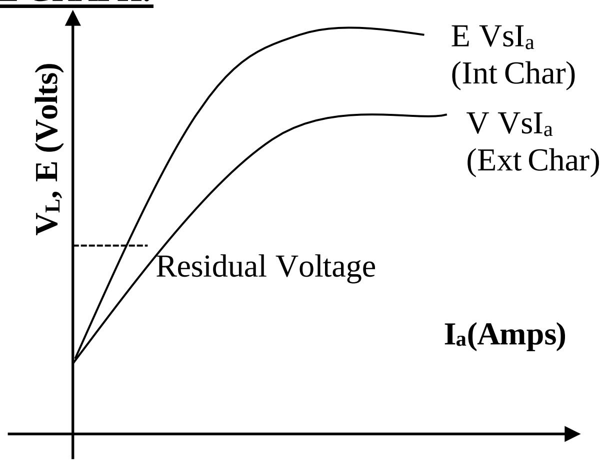
OBSERVATIONS:

$R_a =$ Ω $R_{se} =$ Ω $R = (R_a + R_{se}) =$ Ω

(R_a & R_{se} are found by using DC multimeter)

Sl.No	**Terminal Voltage (V_L) Volts**	**Armature current (I_a) or Load current (I_L)(Amps)**	**$E_g = V_L + I_a R$ (Volts)**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

MODEL GRAPH:



FORMULAE:

E_g : $V_L + I_a (R_a + R_{se})$ (Volts)

E_g : Generated emf in Volts

V : Terminal Voltage in Volts

I_a : Armature Current in Amps

R_a : Armature Resistance in Ohms

R_{se} : Series Field Resistance in Ohms

DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. What is a DC series generator?
2. What are the factors on which the generated emf in a DC series generator depends?
3. Why is value of the series field resistance low?
4. Comment on the shapes of the load characteristics of DC series generator.
5. How does armature reaction affect the terminal voltage of a DC series generator at high load current?
6. What is the voltage at the terminals of a dc series generator running at rated rpm and no load will be?
7. What is the condition of a dc series generator to excite itself?
8. A dc series generator is provided with diverter and is delivering its rated current. If the diverter switch is opened then what is the terminal voltage?
9. When two series generators operating in parallel, what is the purpose of using equalizer bar?
10. A 230V dc series generator is driven at its rated speed. What is the no load voltage across its armature terminals would be?

RESULT:

EXP.NO: 04

Date:

HOPKINSON'S TEST ON DC SHUNT MACHINES

AIM: To conduct the Hopkinson's test on the given pair of DC machines and Predetermine the efficiency

NAME PLATE DETAILS:

Term	D .C Shunt Motor	D.C Shunt Generator
Power	5 H.P , 3.7KW	3KW
Voltage	220V	220V
Current	19A	19A
Speed	1500RPM	1500RPM
Field current	1A	1A

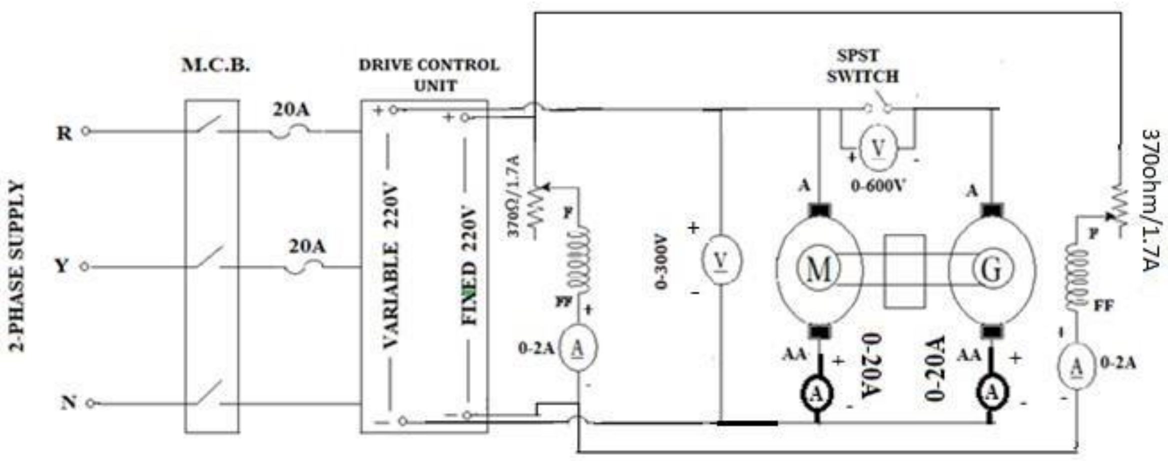
FUSE RATING:

Motor and Generator side:
125% of rated current of DC Motor
125*19/100=23.75≈ 25 A

APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-2)A (0-20) A	Digital Digital	2 1	On Panel On Panel
2	Voltmeter	(0-300)V (0-600)V	Digital Digital	1 1	On Panel On Panel
3	Rheostats	370Ω/1.7A	Wire Wound	2	External
4	Resistive load bank	20A	-	1	External
5	RPM meter	(0-9999)rpm	Digital	1	On Panel
6	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM :



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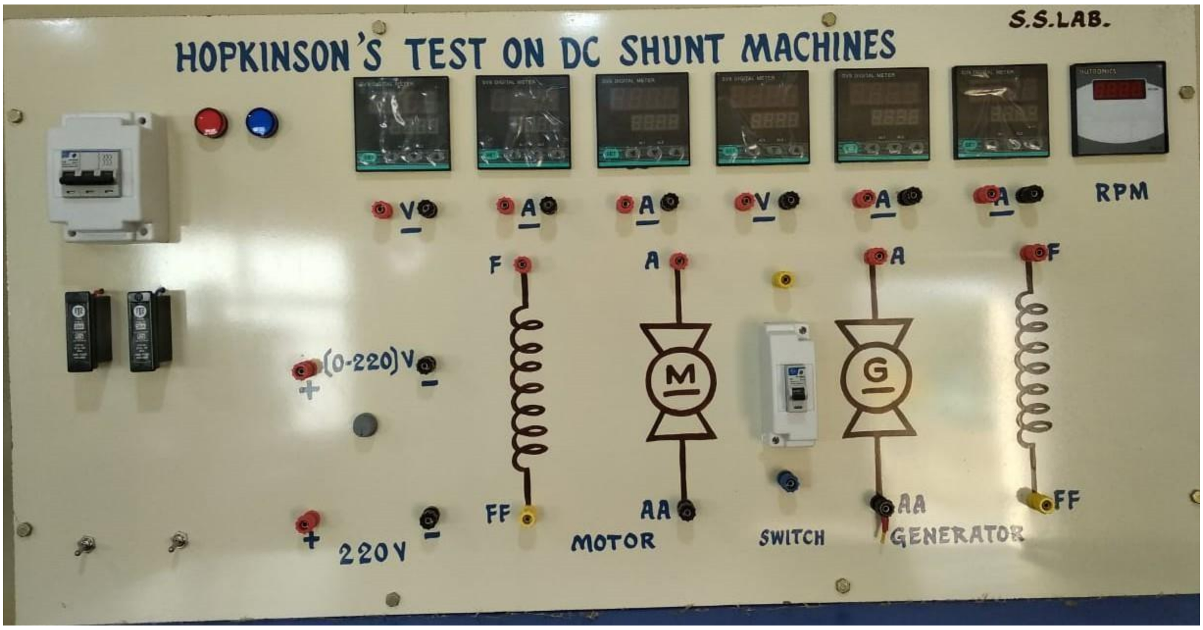


PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the field rheostat of motor and Pot meter of Drive Control Unit are in minimum position and the SPST switch is kept in open condition.
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.

4. By adjusting the motor field rheostat, the motor is brought to rated speed.
5. Then the generator field rheostat is adjusted until the volt meter connected across the SPST switch is zero.
6. The SPST switch is closed and all meter readings are noted
7. After the experiment is completed the various rheostats are brought back to their original position in sequence and then main supply is switched off.

PRECAUTIONS:

1. The field rheostat of the motor must be kept in minimum resistance position.
2. The field rheostat of the generator must be kept in maximum resistance position.
3. The SPST switch is kept open while starting the experiment and it is closed only when the voltmeter connected across the motor and generator shows zero reading.

FORMULAE & NOMENCLATURE:

Let I_a=Supply current to both the armatures from Drive Control Unit.

Then $I_{am} = I_a + I_{ag}$

where I_{am} & I_{ag} are motor and generator armature currents respectively.

Total input power to armature circuit = VI_a = Total Stray losses + Total copper losses (since net output from M-G set is zero)

Generator armature copper loss = $I_{ag}^2 R_{ag}$

Motor armature copper loss = $I_{am}^2 R_{am}$

Generator field copper loss = $I_{fg}^2 R_{fg}$

Motor field copper loss = $I_{fm}^2 R_{fm}$

Total Stray losses = Total input power - Total copper losses

$= VI_a - I_{ag}^2 R_{ag} - I_{am}^2 R_{am}$

Stray losses of each Machine = $\frac{\text{Total Stray losses}}{2}$

Total generator losses = P_{LG} = Stray losses of generator + $I_{fg}^2 R_{fg} + I_{ag}^2 R_{ag}$

Motor input = $P_{in, M} = V I_{am} + I_{fm}^2 R_{fm}$

Generator output = $P_{out, G} = V I_{ag}$

Motor efficiency = $(P_{in, M} - P_{LM}) / P_{in, M}$

Generator efficiency = $(P_{out, G}) / (P_{out, G} + P_{LG})$

OBSERVATIONS:

Motor			Generator			Armature Cu Loss of Gen.	Armature Cu Loss of Motor	Shunt Cu loss of generator	Shunt Cu loss of motor	Efficiency of generator			Efficiency of motor		
V V ol	I_{am} Amps	I_{fm} Amps	V Volts	I_{ag} Amps	I_{fg} Amps	$I_{ag}{}^2 R_{ag}$	$I_{am}{}^2 R_{am}$	$I_{fg}{}^2 R_{fg}$ Watts	$I_{fm}{}^2 R_{fm}$ Watts	I/P	O/P	% η	I/P	O/P	% η

DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. What is the purpose of Hopkinson's test?
2. What are the advantages of Hopkinson's test?
3. What are the conditions for conducting the test?
4. How the power taken from the mains has to supply (is utilized) in this test?
5. Why the adjustments are done in the field rheostat of generator and motor?
6. If the voltmeter across the SPST switch reads zero, what does it indicate?
7. What is the draw back in this test?
8. Two DC **S**hunt machines 200KW each are tested by Hopkinson's. what is the power input in the order of.
9. What are the parameters obtain in the Hopkinson's test?

RESULT:

EXP.NO: 05

Date:

SWINBURNE'S TEST ON DC SHUNT MACHINE

AIM: To predetermine the efficiency of a DC shunt machine by conducting the Swinburne's Test

NAME PLATE DETAILS:

Term	D .C Shunt Motor
Power	5 H.P , 3.7KW
Voltage	220V
Current	20A
Speed	1500RPM
Field current	1A

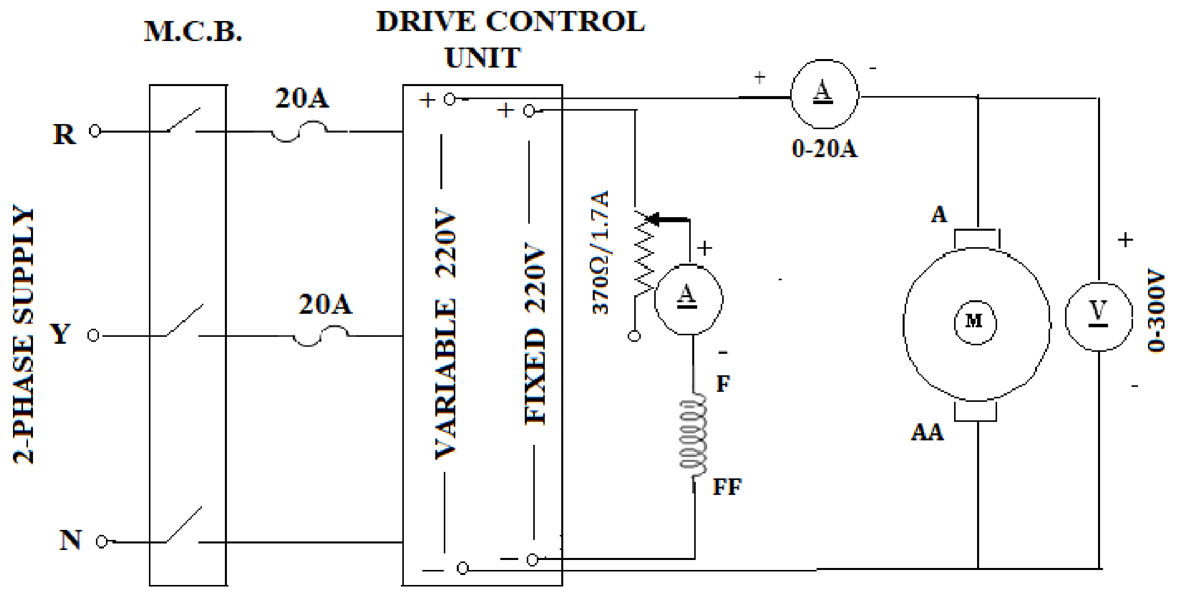
FUSE RATING:

Motor and Generator side:
125% of rated current of DC Motor
125*20/100= 25 A

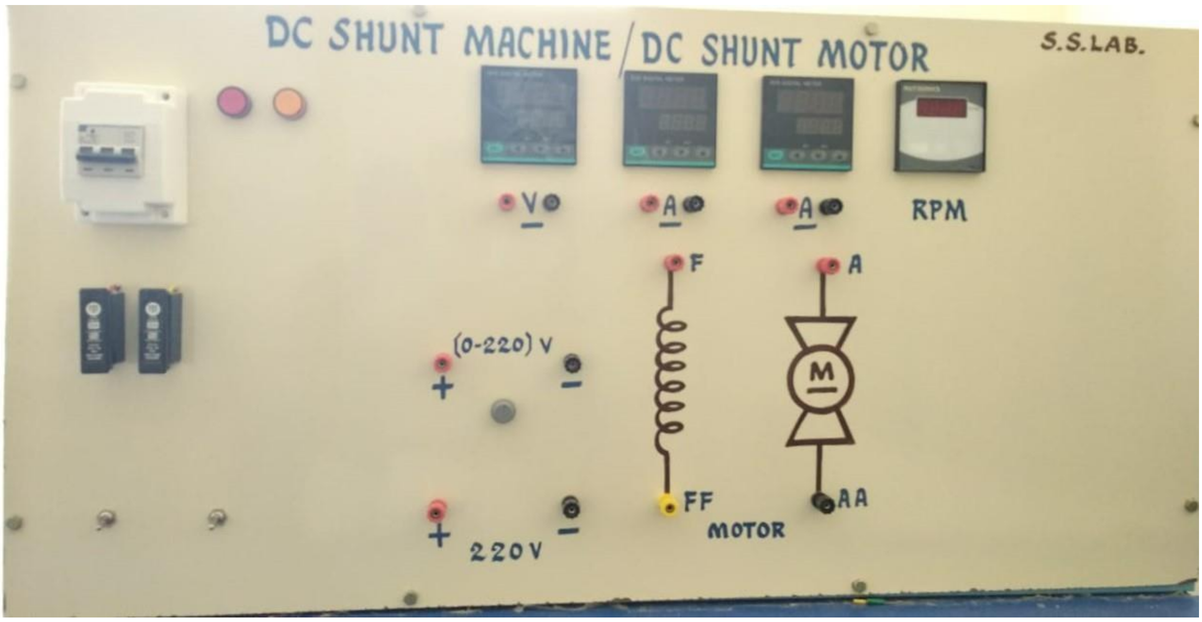
APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-2)A (0-20) A	Digital Digital	1 1	On Panel On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostat	370Ω/1.7A	Wire Wound	1	External
4	RPM meter	(0-9999)rpm	Digital	1	On Panel
5	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM:



PANEL:



PROCEDURE:

(a) Swinburne's Test

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position.

3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.
4. The motor field rheostat is then adjusted until the motor runs at rated speed.
5. Then all the meters readings are tabulated. From this data no load losses are calculated and effieciency is estimated at various loads as explained below.
6. Then the field rheostat is brought to minimum resistance position and MCB is opened.

PRECAUTIONS:

1. Field Rheostat should be kept in the minimum resistance position at the time of starting and stopping the motor.

OBSERVATIONS:

V_S Volts	I_a Amps	I_f Amps	Speed (N) RPM

FORMULAE & NOMENCLATURE:

Calculation of constant losses in Swinburne's test:

Input to the motor on no load = $V_S I_a + I_f^2 R_f$

Variable losses = Armature Cu loss = $I_a^2 R_a$

Total losses on no load= *Input – output*

But output=0

So, total loss on no load=Input at no load

Then, Constant Losses = P_{CL} = I/P-Armature copper loss at no load

$$P_{CL} = V_S I_a + I_f^2 R_f - I_a^2 R_a$$

(Constant loss includes iron loss, mechanical loss and field cu loss)

Predetermination of the performance of the machine when it works as a generator

Let load current on generator = I_L

Let Vg be the rated terminal voltage of the generator

Then Output power = $Vg*I_L$ Watts

Then, $I_A = I_L + I_f$ Amps

Armature cu loss= $I_A^2 R_A$ Watts

Total loss = Constant losses (P_{CL}) + Armature cu loss Watts

I/P = Output + Total losses watts

$$\%\eta = \frac{O/P}{I/P} * 100$$

Predetermination of the performance of the machine when it works as a motor

Let I_A = Armature current

I_F = Rated Field current

Then Supply current (I_S) = $I_A + I_F$

Let V_M be the rated terminal voltage of the motor

Input = $V_S * I_S$

and

Looses = Constant losses + Armature cu losses = $P_{CL} + I_A^2 R_A$

Output = Input – Losses = $V_S * I_S - (P_{CL} + I_A^2 R_A)$

$$\%\eta = \frac{O/P}{I/P} * 100$$

$$= [\{V_S * I_S - (P_{CL} + I_A^2 R_A)\} / (V_S * I_S)] * 100$$

PREDETERMINATION OF LOSSES AND EFFICEINCY AT DIFFERENT LOADS:

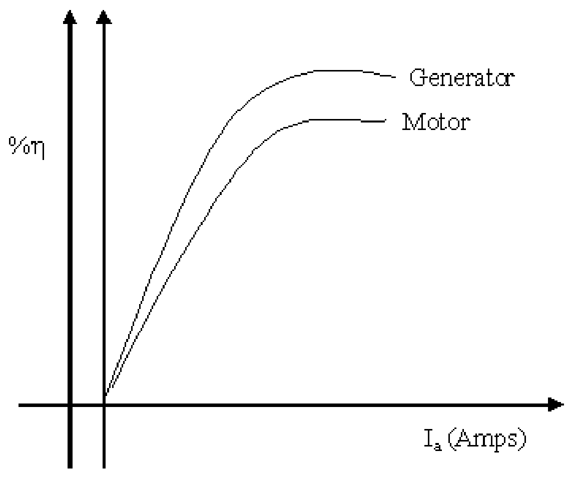
As a Motor:

Sl.No	**Rated Supply Voltag e V_S (Volts)**	**Armatu re Current I_A (Amps)**	**Field Curren t I_F (Amps)**	**Supply Curren t $I_S = I_A + I_F$ (Amps)**	**Arm. Copper losses $I_A^2 R_A$ (Watts)**	**Total losses ($P_{CL} + I_A^2 R_A$) (Watts)**	**Input Power $V_S I_S$ (Watts)**	**Output Power I/P - losses (Watts)**	**Efficiency η %**
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									

As a Generator:

Sl.No	Rated Terminal Voltage V_g (Volts)	Load Current I_L (Amps)	Field Current I_F (Amps)	Arm. Current $I_A = I_L + I_F$ (Amps)	Arm. Copper losses $I_A^2 R_A$ (Watts)	Total losses $(P_{CL} + I_A^2 R_A)$ (Watts)	output Power $V_g I_L$ (Watts)	Input Power O/P + losses (Watts)	Efficiency η %
1.									
2.									
3.									
4.									
5.									
6.									
7.									
8.									

<u>MODEL GRAPH:</u>



DRAW THE CIRCUIT DIAGRAM

RESULT

EXP.NO: 06

Date:

SPEED CONTROL DC SHUNT MOTOR

AIM: To control the speed of DC shunt motor under loaded condition.

i. Field resistance control.
ii. Armature resistance control.

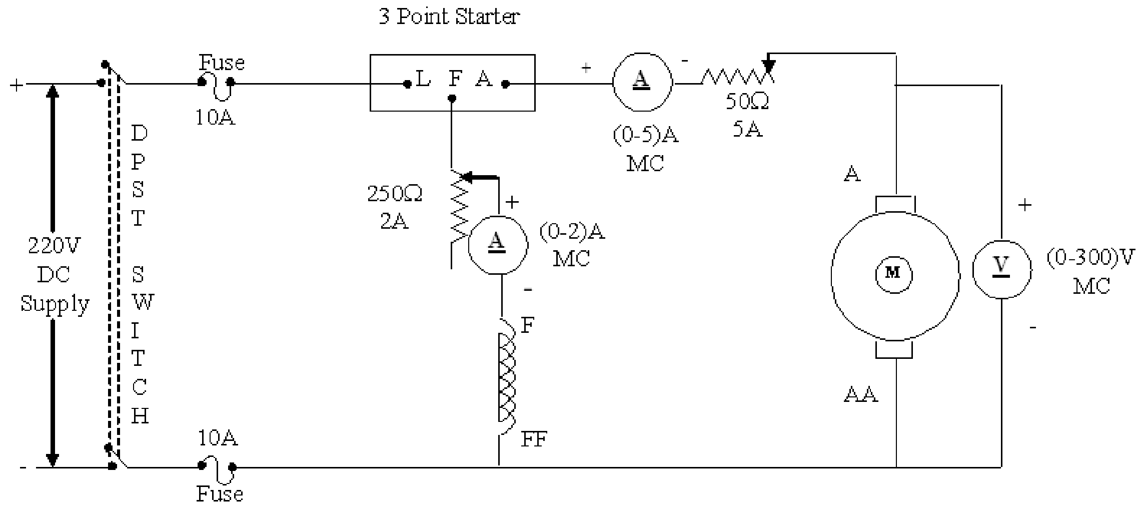
NAME PLATE DETAILS:

Term	D .C Shunt Motor
Power	5 H.P , 3.7KW
Voltage	220V
Current	20A
Speed	1500RPM
Field current	1A

APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-2)A (0-20) A	Digital Digital	1 1	On Panel On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostat	370Ω/1.7A	Wire Wound	1	External
4	RPM meter	(0-9999)rpm	Digital	1	On Panel
5	Connecting Wires	-	-	As Required	External

CIRCUIT DIAGRAM:



i. Armature Voltage Control

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position.
3. Observing all the precautions and the motor is started using drive control unit and the speed is increased until the rated armature voltage is reached
4. The motor field rheostat is then adjusted until the motor runs at rated speed
5. The motor is now ready to work at rated armature voltage and rated speed.
6. Now to get variable speeds by AVC method, the field current (I_f) is kept constant value and the potentiometer of drive control unit is adjusted to get various below base speeds.
7. Note down the corresponding armature voltages and motor speeds.
8. This procedure is repeated for different values of field current.

ii. Field Control

1. The pot meter of Drive Control Unit is adjusted to maintain constant rated armature voltage.
2. Now the field rheostat is varied in steps so as to decrease the field current. Corresponding motor speeds and field currents are noted.
3. This procedure is repeated for reduced armature voltage (Lesser than the rated armature voltage).
4. After the experiment is completed the various rheostats are brought back to their original position in sequence and then main supply is switched off.

OBSERVATIONS:

ARMATURE VOLTAGE CONTROL:

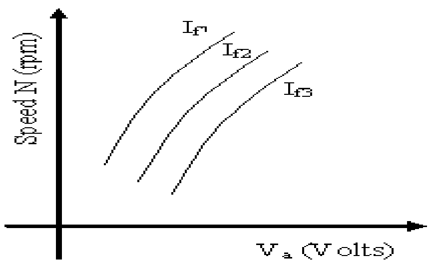
Sl. No:	I_{f1} =		I_{f2} =	
	Armature Voltage V_a (Volts)	Speed N (rpm)	Armature Voltage V_a (Volts)	Speed N (rpm)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

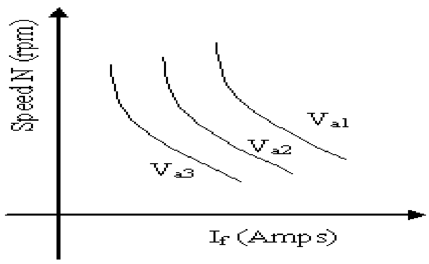
FIELD CONTROL:

Sl. No:	V_{a1} =		V_{a2} =	
	Field Current I_f (A)	Speed N (rpm)	Field Current I_f (A)	Speed N (rpm)
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

MODEL GRAPHS:

i) Armature Voltage Control
ii) Field Control





DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. What is the purpose of Swinburne's test?
2. What are the losses that constitute constant losses in a DC machine?
3. What are the assumptions made in Swinburne's test?
4. In this test the shunt machine has to run as a------------?
5. The efficiency of DC machine is generally higher when it works as a generator than works as a motor. Is this statement true or false? Justify your answer with proper reasons.
6. What are Factors determining the Speed of a Dc Motor?
7. How the speed control can be achieved by above rated speed control method?
8. What is the minimum speed limit of given machine
9. How the speed control can be achieved by below rated speed control method?
10. In Swinburne method for the determination of a efficiency of a dc machine

    a, the no load losses are measured and copper losses are calculated
    b, the no load losses are calculated and copper losses are measured.

RESULT:

EXP.NO: 07

Date :

BRAKE TEST ON DC SHUNT MOTOR

AIM: To obtain performance characteristics of DC Shunt motor.

NAME PLATE DETAILS:

Term	D .C Shunt Motor
Power	5 H.P , 3.7KW
Voltage	220V
Current	20A
Speed	1500RPM
Field current	1A

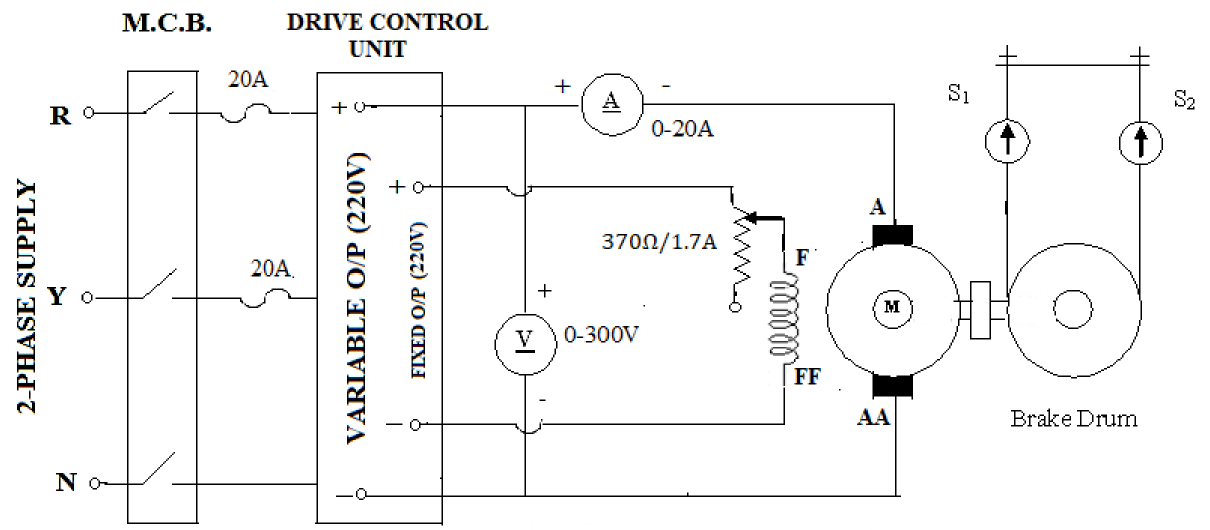
FUSE RATING:

125% of rated current=125* 20/100=25 A

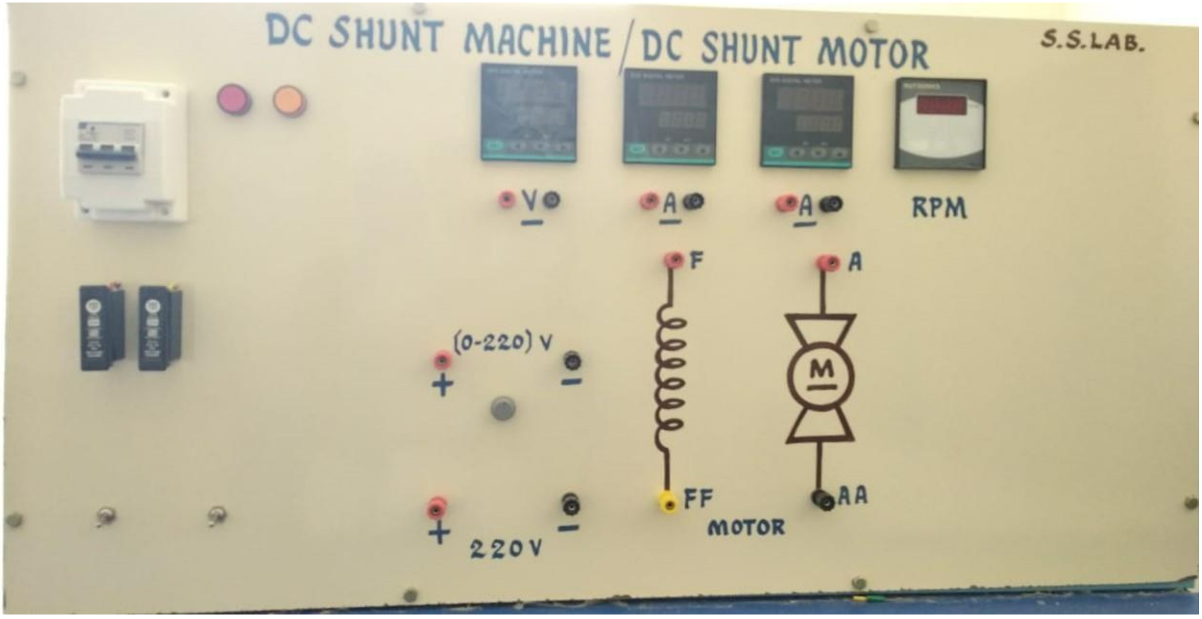
APPARATUS REQUIRED:

S.No:	Name of the Apparatus	Range	Type	Quantity	Availability
1	Ammeter	(0-20)A	Digital	1	On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostat	370Ω/1.7A	Wire Wound	1	External
4	RPM meter	(0-9999) rpm	Digital	1	On Panel
5	Connecting Wires	-	-	As Required	External

TEST SETUP:



PANEL:



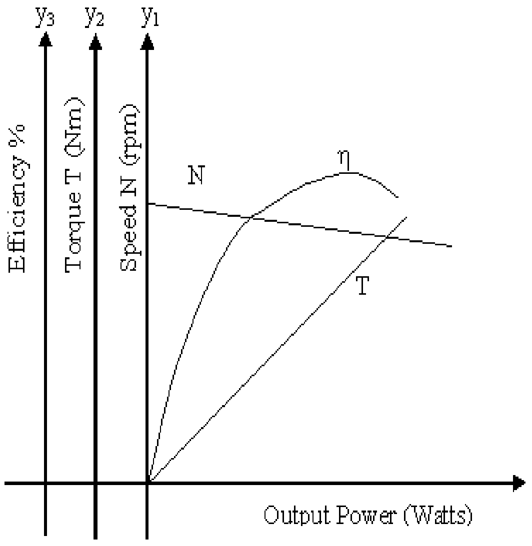
PROCEDURE:

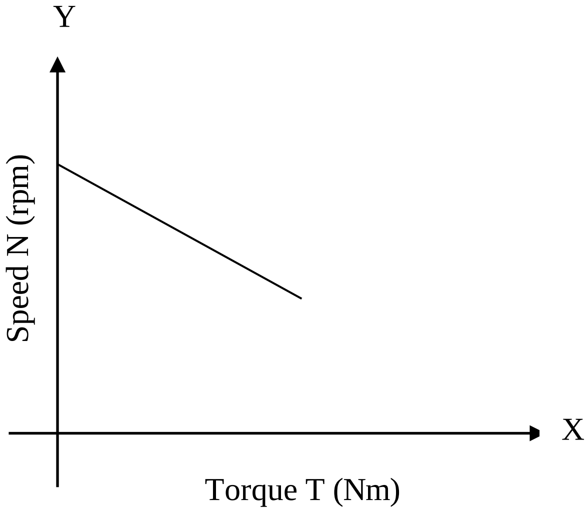
1. Connections are made as per the circuit diagram
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position.
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.
4. By adjusting the motor field rheostat, the motor is brought to rated speed.
5. The no load readings are tabulated.
6. The load is applied with the help of Mechanical Loading arrangement with Load cells, gradually in small steps and each step, take the reading of ammeters, voltmeter and load cells.
7. The motor is then brought to no load condition and field rheostat to minimum position and MCB is opened.

PRECAUTIONS:

1. The field rheostat of motor should be at minimum resistance position.
2. There should not be any load on the motor (brake drum) while starting and stopping.

MODEL GRAPHS:





FORMULAE:

Torque= T = S*9.81*r N-m

Input = $V_S * I_A + I_{SH}^2 R_{SH}$ Watts

$$O/P = \frac{2\pi NT}{60} \text{ Watts}$$

$$\%\eta = \frac{O/P}{I/P} * 100$$

OBSERVATIONS:

D = 2πr =

S.NO.	V_S (Volts)	I_A (Amps)	I_{SH} (Amps)	N (rpm)	S (KG)	I/P (Watts)	T (N-m)	O/P (Watts)	% EFFIECIENCY
1									
2									
3									
4									
5									
6									

DRAW THE CIRCUIT DIAGRAM

VIVA QUESTIONS:

1. Why should the field rheostat be kept in the position of minimum resistance?
2. What is the loading arrangement used in a dc motor?
3. How can the direction of rotation of a DC shunt motor be reversed?
4. What are the mechanical and electrical characteristics of a DC shunt motor?
5. What are the applications of a DC shunt motor?
6. Why the DC Motor is said to be constant speed Motor?
7. What is the speed of the shunt motor from no load the full load?
8. In what way the speed of a dc shunt motor can be increased above its normal speed?
9. What is the method for the determination of the efficiency of a dc machine in brake test?

10.KW, 220V dc shunt machine has four terminals brought out through four leads. For this machine. The armature winding has thick and field winding has thin wires

a. Both the windings are thin
b. Armature is thin and field is thick

Choose the correct and give reason

RESULT:

EXP.NO: 08

Date :

O.C & S.C TEST ON SINGLE PHASE TRANSFORMER

AIM: To conduct O.C. & S.C. test on a given transformer and predeterminations of

1) Efficiency,
2) Regulation,
3) Equivalent circuit

NAME PLATE DETAILS:

S.NO	Specifications	Ratings
1	Voltage	220/110v
2	output	3kVA
3	cycle	50Hz
4	phase	1-ϕ

APPARATURS REQUIRED:

S.No.	Equipment	Type	Range	Quantity
1.	Ammeter	DIGITAL	(0-2)A	1
2.	Ammeter	DIGITAL	(0-20)A	1
3.	Voltmeter	DIGITAL	(0-300)V	1
4.	Voltmeter	DIGITAL	(0-150)V	1
5.	Wattmeter	DIGITAL	300V,2A,LPF	1
6.	Wattmeter	DIGITAL	75V,20A,UPF	1
7.	1- Φ auto transformer	-	230/(0-270)V,2KVA	1
8.	Connecting wires	Copper	1.5sqmm	Required

THEORY:

These two tests on a transformer helps to find determine

1. The parameters of equivalent circuit
2. The voltage regulation
3. Efficiency

Complete analysis of the transformer can be carried out once it's equivalent circuit parameters are known. The power required during these two tests is equal to the appropriate power loss occurring in the transformer

O.C.TEST:

This test is conducted by opening the HV side of a transformer. The core loss of the transformer can be determined from this test. It also gives the no-load current I0, which is used to calculate the parameters R0, Xm of the magnetizing circuit. The transformer is connect as indicated in the ckt diagram. One of the windings usually the low voltage winding is connected to the supply voltage source while the high voltage winding is kept open..This ensure magnification of the no-load current I0 , The rated voltage applied to the transformer using auto- transformer, the ammeter gives the total power loss and the ratio of voltmeter readings V1/V2 gives the ratio of the turns.

No load power factor (CosΦ0) = W0/(I0 * V1)

Where W0 = open ckt power in watts

I0 = Open ckt current in Amps

V=Open ckt voltage in Volts

No- load working component of current (Iw) = I0 Cos Φ0

No-load working magnetizing component of current (Iμ) = I0 Sin Φ0

R0 =V0/ Iwin ohms

X0= V0/ Iμ in ohms

S.C. TEST:

This test gives the full load copper loss. In this test, secondary side low voltage winding is short circuited. A small voltage applied to the primary and increased carefully till the current (Isc) in the primary winding reaches the rated full-load value. Under these conditions, the copper loss inthe in the winding is same as that on full load.

Equivalent impedance referred to HV side

Z02 = Vsc/Isc in ohms. Equivalent resistance referred to HV side

R02 = Wsc/I^2sc in ohms. Equivalent reactancereferred to HV side

X02=$\sqrt{(Z^2 02 - R^2 02)}$ in ohms

Equivalent circuit of 1-φ transformer referred to lv side:

(CosΦ0) = W0/(I0 * V1)(Iw) = I0 Cos Φ0
(Iμ= I0 Sin Φ0

Z02 = Vsc/Isc ,

R02 = Wsc/I^2sc,

$X_{02}=\sqrt{(Z^2_{02} - R^2_{02})}$

Transformation ratio (K) = V2/V1

Equivalent resistance referred to LV side (R_{01}) = R_{02} / K^2
Equivalent reactance referred to LV side (X_{01}) = X_{02}/K^2

Efficiency & Regulation of 1- Φ transformer:

Output power = (X*KVA*Cos Φ)

Where X = fraction of load. (X=1/4, 1/2, 3/4,1)

KVA = power rating of transformer,

CosΦ = power factor

Iron losses

(Wi) = W0 Copper losses (Wcu)= X^2*Wsc

Total losses= Cu losses + Iron losses.

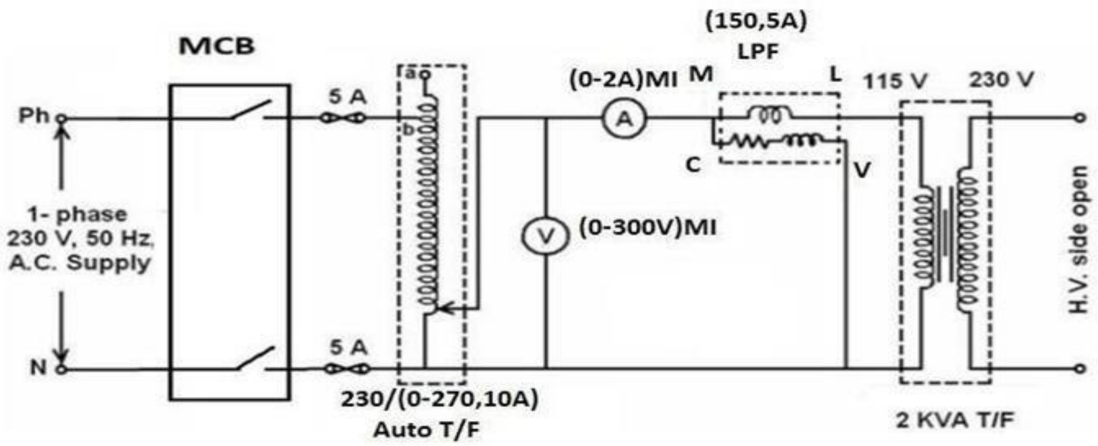
$$\textbf{Efficiency} = \frac{\text{Output power}}{\text{(output power+ losses)}} * 100$$

$$\textbf{Regulation} = \frac{X.I_{sc}\,[\,R_{02}\cos\Phi \pm X_{02}\sin\Phi\,]}{V_2} * 100$$

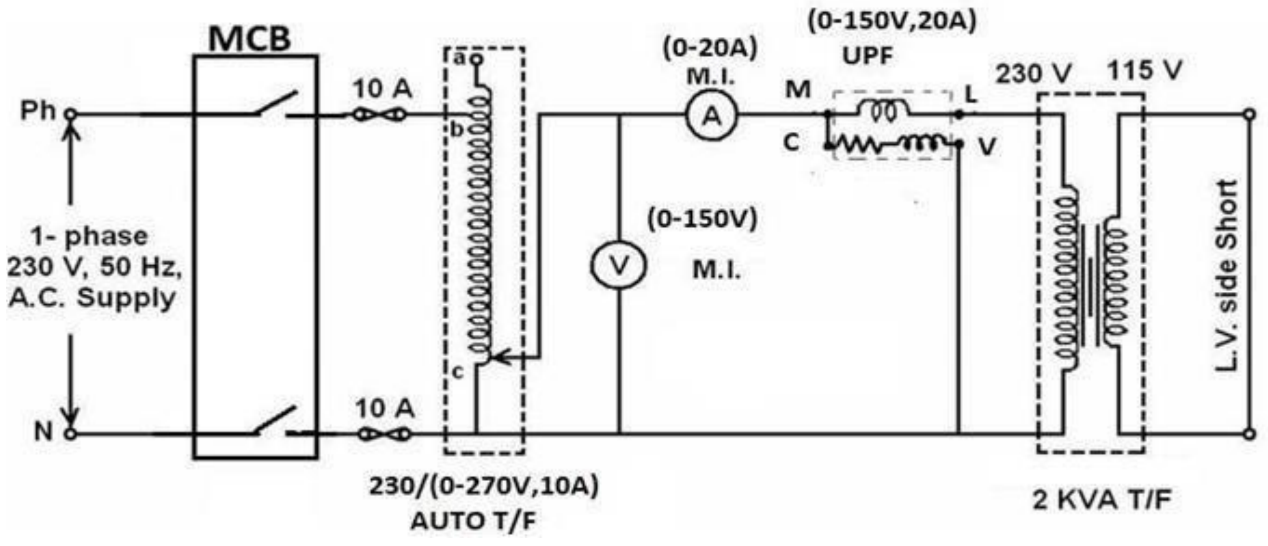
Where " +" for lagging.

"-" for leading.

OPEN CIRCUIT:



SHORT CIRCUIT:



PROCEDURE:

Open circuit test:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated voltage to the Primary winding by using variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then variac is brought back to minimum position and switch OFF the supply.
6. Calculate $\mathbf{R_o}$ and $\mathbf{X_o}$ from the readings.

Short Circuit Test:

1. Connections are made as per the circuit diagram.
2. Ensure that variac is set to zero output voltage position before starting the experiment.
3. Switch ON the supply. Now apply the rated current to the Primary winding by using Variac.
4. The readings of the Voltmeter, ammeter and wattmeter are noted down in Tabular form.
5. Then variac is set to zero output position and switch OFF the supply.
6. Calculate $\mathbf{R_{01}}$ and $\mathbf{X_{01}}$ from the readings.

OBSERVATIONS:

O.C. Test

S.No.	V_1(Volts)	I_O(Amps)	W_O(Watts)

S.C.Test:

S.No.	V_{SC}(Volts)	I_{SC}(Amps)	W_{SC}(Watts)

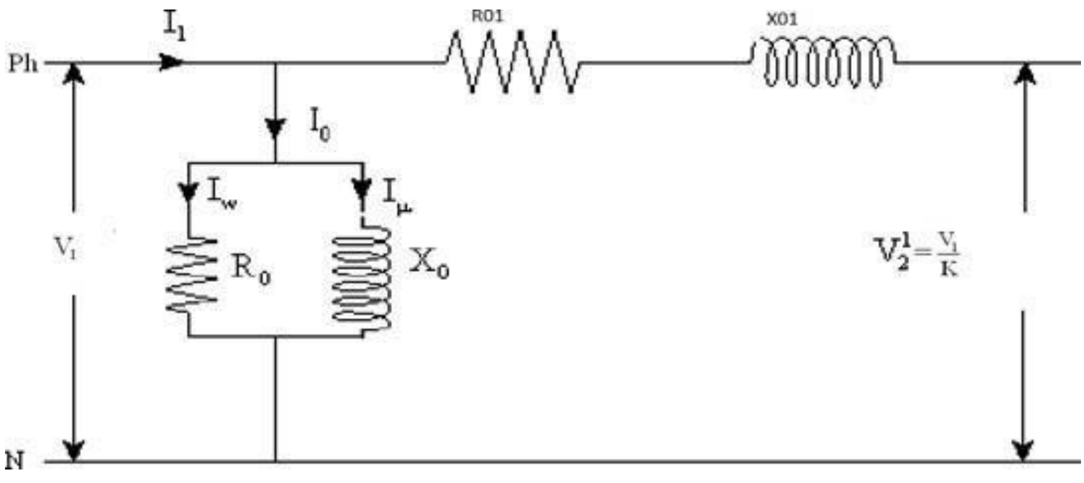
TABULATION TO FIND THE EFFICIENCY:

Fractinal load (X)	O/P (watts)	Iron losses (Wi)	Cu losses (Wcu)	Total losses	%η
¼					
½					
¾					
1					

TABULATION TO FIND OUT THE REGULATION:

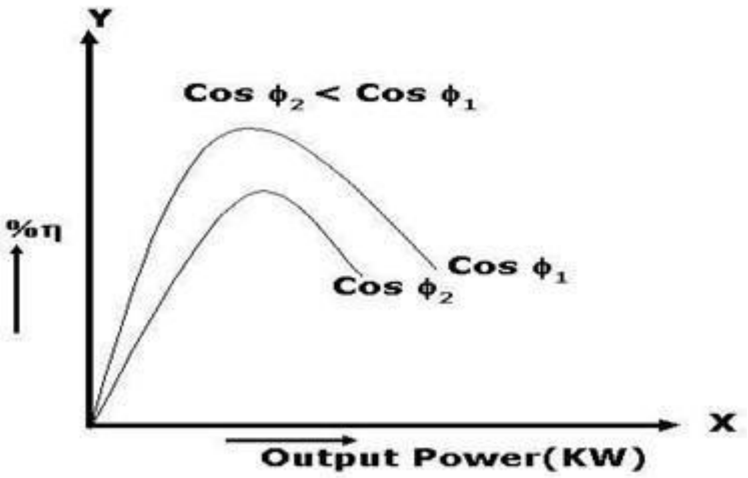
Fraction of load (X)	P.F(CosΦ)	%Reg(lag)	%Reg(lead)
¼			
½			
¾			
1			

EQUIVALENT CIRCUIT DIAGRAM:

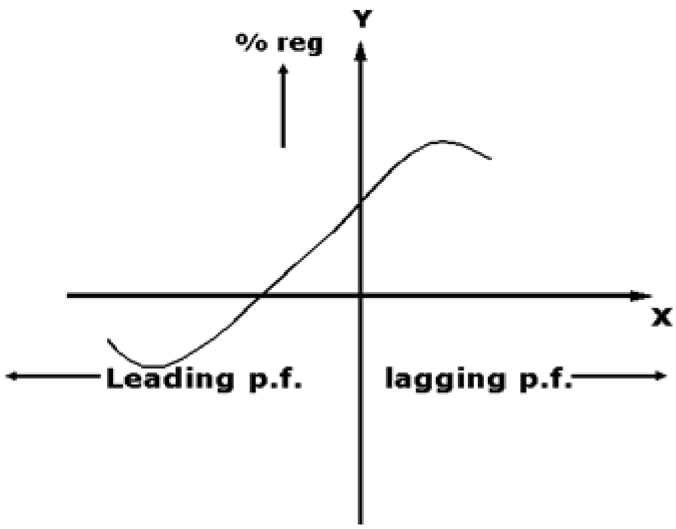


EXPECTED GRAPHS:

GRAPHS: Plots drawn between



(i) % efficiency Vs output



% Regulation Vs Power factor

VIVA – VOCE QUESTIONS:

1. How would you calculate the multiplying factor of a wattmeter?
2. Why should we select LPF & UPF wattmeter's while conducting OC & SC test?
3. Why Iron losses are considered as negligible while conducting SC test?
4. Why copper losses are considered as negligible while conducting OC test?
5. What are the Advantages and Disadvantages of OC & SC test?
6. What are the requirements to be fulfilled while conducting OC & SC tests?
7. Why the no-load power factor of a transformer is small?
8. Why the transformer rating is in KVA?
9. What is the effect of variation of voltage & frequency on Iron Losses?
10. How the Hysteresis & Eddy current losses are reduced?

RESULT:

EXP.NO: 09

Date:

FIELD TEST ON TWO IDENTICAL SERIES MACHINES

AIM: To determine the efficiency of two mechanically coupled series machines by conducting field test.

NAME PLATE DETAILS:

Term	D.C Series Motor	D.C Series Generator
Power	3KW	3KW
Voltage	220V	220V
Current	19A	19A
Speed	1500RPM	1500RPM
Field current	-	-

FUSE RATING:

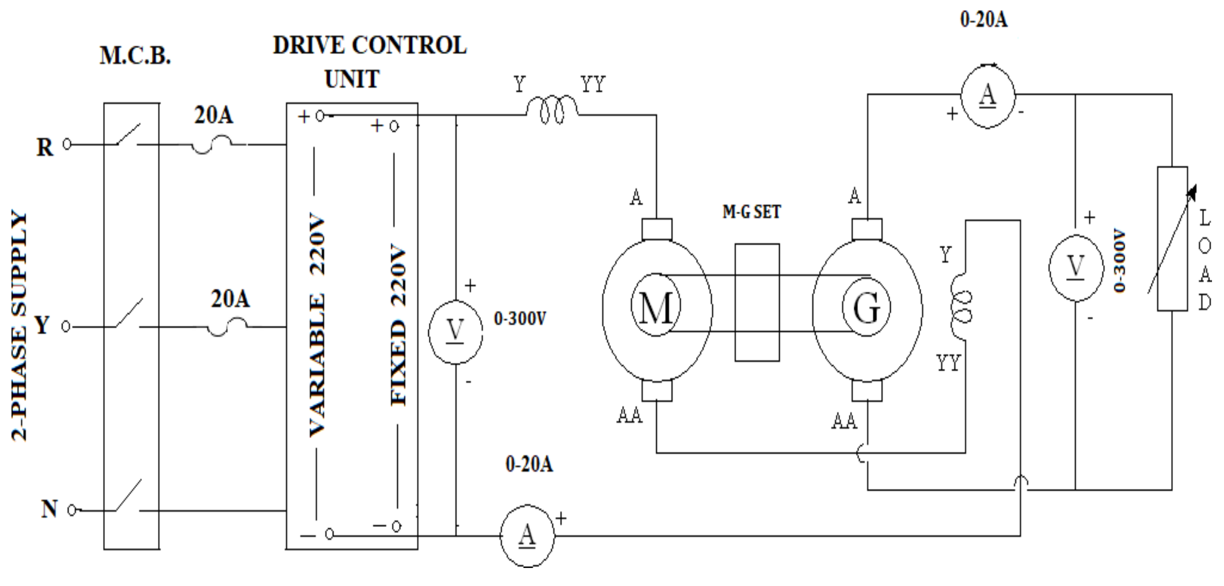
Fuse rating = 125 % of rated current

= 125/100 * 19 = 23.75 A ≈ 25 A

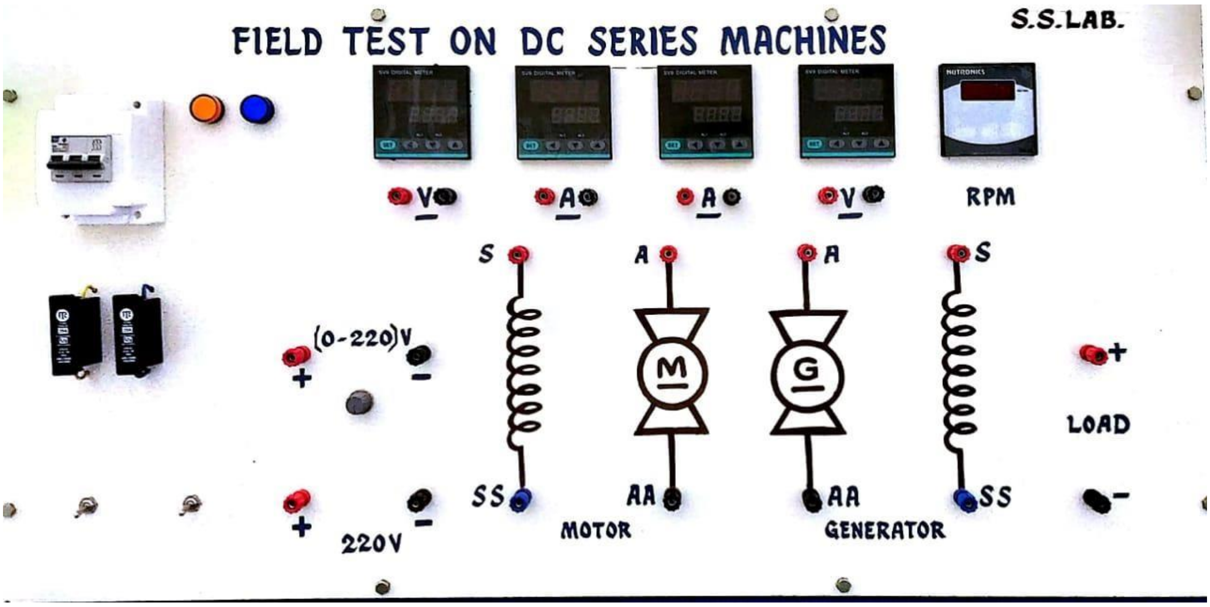
APPARATUS REQUIRED:

SL.NO	APPARATUS	RANGE	TYPE	QTY	Availability
1	Voltmeter	0 – 300 V	Digital	2	On Panel
2	Ammeter	0 – 20 A	Digital	2	On Panel
3	RPM meter	--	Digital	1	On Panel
4	Resistive load Bank	20A	-	1	External
5	Connecting Wires	-	-	As Required	External

TEST SETUP:



PANEL:



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Before starting the motor, Ensure that the Pot meter of Drive Control Unit is in minimum position.
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed.
4. One machine runs normally as a Motor and other acting as generator whose output is wasted in a variable load R.
5. Then the load on the generator is adjusted until the motor current reaches its rated value, note the Ammeter and voltmeter readings and calculate efficiency.

PRECAUTIONS:

1. Ensure that the motor field and generator field are connected in series.
2. There should be a load on the generator, while starting and stopping.

OBSERVATIONS:

MOTOR (Ra= Ω Rse= Ω) GENERATOR (Ra= Ω Rse= Ω)

Sl. No.	Input to Motor V_1Volts	Motor current I_1Amps	Generator Voltage V_2Volts	Generator current I_2Amps
1				

FORMULAE & NOMENCLATURE:

Let,

'V_1'= Supply voltage

I_1= Motor current.

V_2= Terminal potential difference of Generator.

I_2= Load Current.

Input of whole set=$V_1 I_1$=

Output = $V_2 I_2$=

Total losses in the set (w_t) = ($V_1 I_1$ - $V_2 I_2$) =

Armature & Field copper losses (w_{cu}) = (R_a + 2 R_{se}) I_1^2 + $I_2^2 R_a$ =

Stray Losses in Two Machines = (w_t - w_{cu}) =

Stray Losses for each Machine =

Motor Efficiency:

Motor Input = $V_1 I_1$=

Motor Losses =I_1^2 (R_a + Rse) + C/2=

% Motor Efficiency = { [$V_1 I_1$ - (I_1^2 (R_a + R_{se}) + C/2)] / $V_1 I_1$ } * 100=

Generator Efficiency:

Generator output = $V_2 I_2$=

Generator Losses =$I_1^2 R_{se}$ + $I_2^2 R_a$ + C/2 =

% Generator Efficiency = {$V_2 I_2$ / [$V_2 I_2$ + ($I_1^2 R_{se}$+ $I_2^2 R_a$ + C/2)] } * 100 =

VIVA QUESTIONS:

1. Field Test is conducted for ……. Machine in order to determine the efficiency
2. What are the Advantages &disadvantages of Field Test.?
3. How the machines are loaded in Field's test?
4. What will happen if the field of one machine get shorted?
5. Can the Series Motor be run under no-load? Justify the answer?
6. How the Series Motor can Develop High Starting Torque?
7. What are the Applications of DC Series Motors?
8. What type of Starter is used to start a dc series motor?
9. Will the Generator action takes place in DC Motor?
10. In field test in two series machines
    a. armature voltage of generator is more than the armature voltage of motor
    b. generator field current is more than motor field current
    c. generator field current is equals to motor field current

Choose the correct and give the reason

RESULT:

EXP.NO: 10

Date :

BRAKE TEST ON DC COMPOUND MOTOR

AIM: To obtain performance characteristics of DC compound motor as

1. Cumulative compound motor
2. Differential compound motor

NAME PLATE DETAILS:

Term	D .C Compound Motor
Power	3 H.P , 2.2KW
Voltage	220V
Current	12A
Speed	1500RPM
Field current	1A

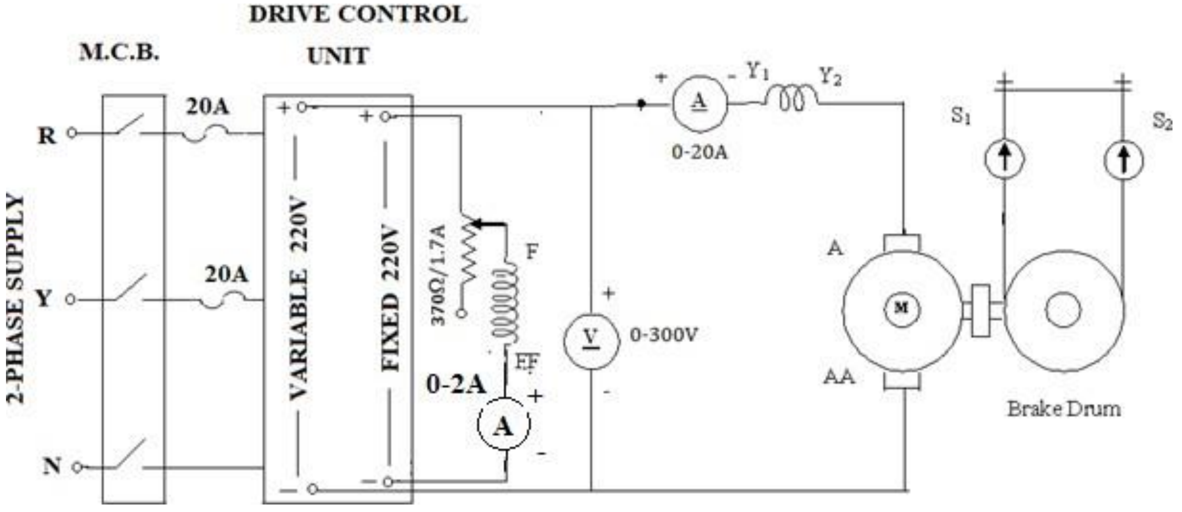
FUSE RATING:

125% of rated current=125*12/100=15 A

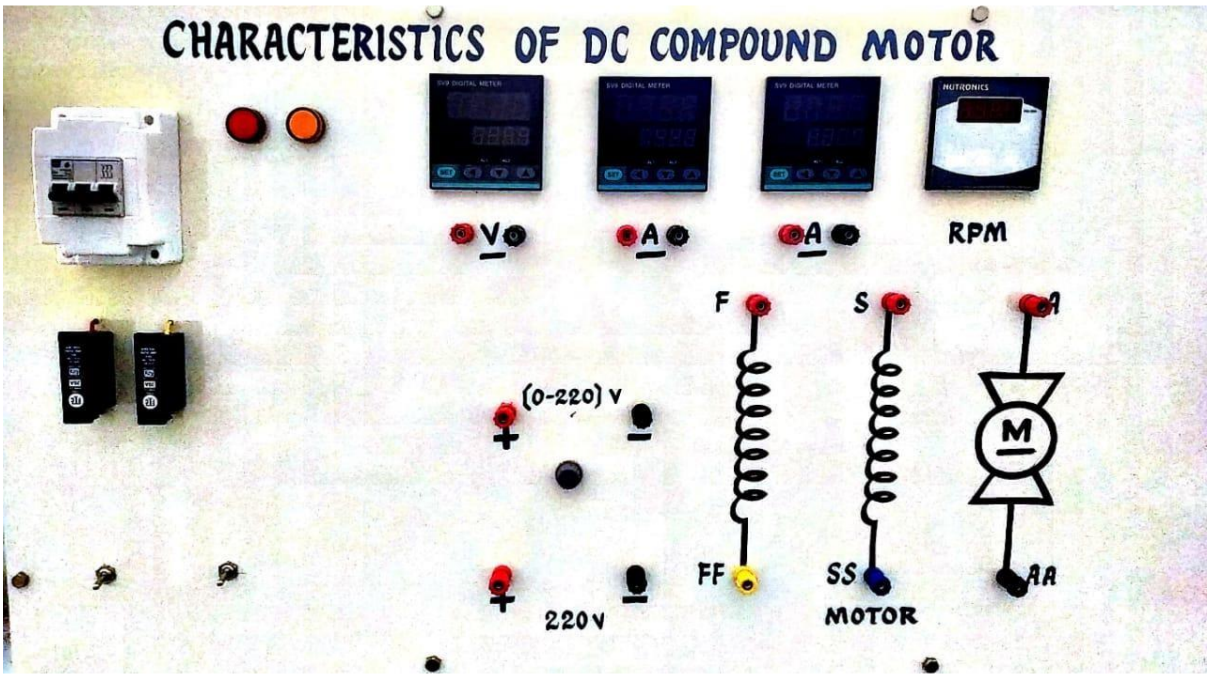
APPARATUS REQUIRED:

S. No	Name of the Apparatus	Range	Type	Quantity	**Availability**
1	Ammeter	(0-2)A (0-20) A	Digital Digital	1 1	On Panel On Panel
2	Voltmeter	(0-300)V	Digital	1	On Panel
3	Rheostat	370Ω/1.7A	Wire Wound	1	External
4	Tachometer	(0-9999)rpm	Digital	1	On Panel
5	Connecting Wires	-	-	As Required	External

TEST SETUP:



PANEL:



PROCEDURE:

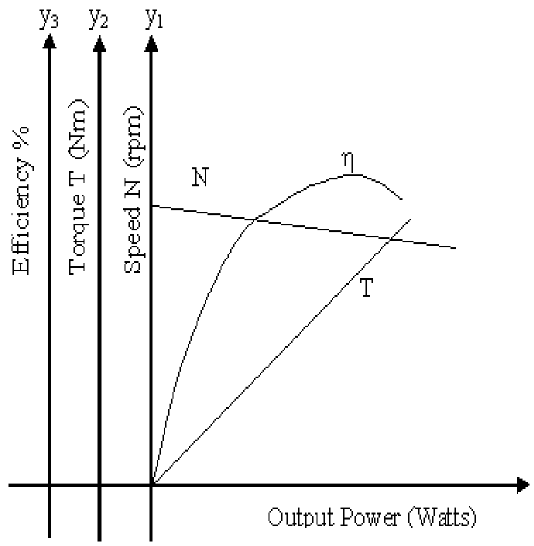
1. Connections are made as per the circuit diagram.(To obtain differential compounding the connections of Y1 and Y2 terminals are interchanged)
2. Before starting the motor, Ensure that the field rheostat and Pot meter of Drive Control Unit are in minimum position. Similarly mechanical loading is also kept in minimum condition.
3. Observing all the precautions, the motor is started using Drive Control Unit and the speed is increased until the rated armature voltage (of motor) is reached. At this instant the speed would be slightly lesser than the rated speed

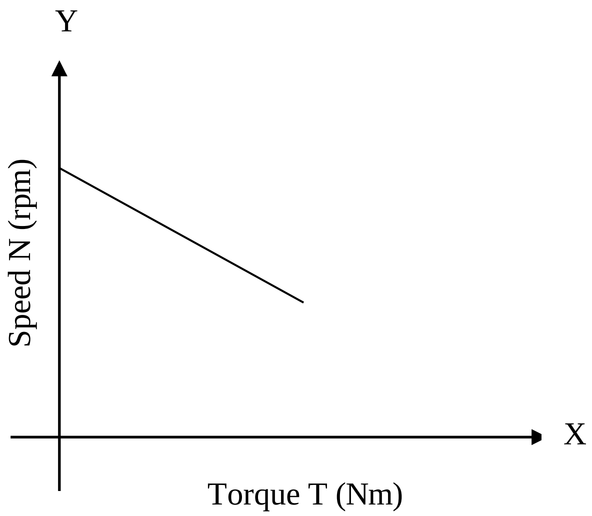
4. By adjusting the motor field rheostat, the motor is brought to rated speed.
5. The no load readings are tabulated.
6. The load is applied with the help of Mechanical Loading arrangement with Load cell, gradually in small steps and at each step, the readings of ammeter, voltmeter and load cells are taken.
7. The motor is then brought to no load condition and field rheostat to minimum position, then MCB is opened.

PRECAUTIONS:

1. The field rheostat of motor should be at minimum resistance position.
2. There should not be any load on the motor (brake drum) while starting and stopping.

MODEL GRAPHS:





FORMULAE:

Torque= T = S*9.81*r N-m

Where S is the differential force i.e. difference between the two load cells (Kgf)

Input = $V_S*I_A + I_{SH}^2R_{SH}$ Watts

$$O/P = \frac{2\pi NT}{60} \text{ Watts}$$

$$\%\eta = \frac{O/P}{I/P}*100$$

OBSERVATIONS:
DIFFERENTIALLY COMPOUND:

S.NO.	V_S (Volts)	I_A (Amps)	I_{SH} (Amps)	N (rpm)	S KG	I/P (Watts)	T (N-m)	O/P (Watts)	% EFFIECIENCY
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

CUMULATIVE COMPOUND:

S.NO.	V_S (Volts)	I_A (Amps)	I_{SH} (Amps)	N (rpm)	S KG	I/P (Watts)	T (N-m)	O/P (Watts)	% EFFIECIENCY
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

VIVA QUESTIONS:

1. What are types of Dc compound motor?
2. How can the same compound motor run as cumulative & differential compound mode?
3. Why speed Decreases as load increases in Cumulative compound motor?
4. Why Speed Increases as load Increases in Differential compound motor?
5. What are the applications of DC Cumulative compound Motors?
6. What is the necessity of Starter?

7. In what way 4.point is different from 3.point starter?
8. What is back emf? What is its significance?
9. What are the best suitable applications of cumulative compound motor?
10. A DC cumulative compound motor delivers rated load torque at rated speed. If the series field is shorted circuited, then what will be the armature current and speed?

RESULT: