Vidya Jyothi Institute of Technology

(An Autonomous Institution)
(Accredited by NAAC & NBA, Approved by AICTE New Delhi & Permanently Affiliated to JNTUH)
Aziz Nagar Gate, C.B. Post, Hyderabad-500 075

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

B. Tech. II Year II Semester

L	T	P	C
0	0	2	1

ELECTRICAL MACHINES – I LABORATORY

Course Code:A14283

Course Outcomes: After the completion of this course, a student must demonstrate the knowledge and ability to

CO1. Identify losses, Output, and efficiency of DC motors

CO2. Identify losses, Output, and efficiency of DC generators

CO3 Apply speed control methods on DC motors.

CO4 Analyze the magnetization characteristics of DC shunt generator to determine its parameters.

CO5 Infer the efficiencies of DC Series Machines.

List of Experiments

Any ten of the following experiments are required to be conducted.

1. Magnetization characteristics of a DC Shunt Generator.
2. Load test on DC Shunt Generator
3. Brake test on DC compound motor.
4. Load test on DC Series Generator
5. Brake test on DC compound motor
6. Hopkinson's test on DC Shunt machines.
7. Field's test on DC Series machines.
8. Separation of losses in DC shunts motor.
9. Retardation test on DC shunt motor.
10. Speed control of DC shunt motor.
11. Swinburne's test on DC shunt machine.
12. Brake Test on DC shunt Motor.

Head of the Department
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Vidya Jyothi Institute of Technology
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Correlation of COs with Experiments

S. No	Name of the Experiment	COs Mapped
1	Magnetization characteristics of a DC Shunt Generator.	CO 4
2	Load test on DC Shunt Generator	CO2
3	Brake test on DC compound motor.	CO1
4	Load test on DC Series Generator	CO2, CO5
5	Brake test on DC compound motor	CO1
6	Hopkinson's test on DC Shunt machines.	CO1, CO2
7	Field's test on DC Series machines.	CO5
8	Separation of losses in DC shunts motor.	CO1, CO2
9	Retardation test on DC shunt motor.	CO2
10	Speed control of DC shunt motor.	CO3
11	Swinburne's test on DC shunt machine.	CO1, CO2
12	Brake Test on DC shunt Motor.	CO2

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Programme Outcomes (POs)

Engineering Graduates will be able to:

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

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

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

9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. 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.

11. 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.

12. 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)

PSO 1: Apply the fundamentals of Electrical and Electronics Engineering to analyze and synthesize problems of Electric Circuits, Electronic Circuits, Control Systems, Electrical Machines and Power Systems.

PSO 2: Apply the appropriate techniques and modern engineering hardware and software tools in Electrical Engineering to engage in life-long learning and to successfully adapt in multi-disciplinary environments.

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CO – PO Mapping

A14283	ELECTRICAL MACHINES LAB- I											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C227.1	3	3	2	3	-	-	-	-	3	-	-	2
C227.2	3	3	2	3	-	-	-	-	3	-	-	2
C227.3	3	3	2	3	-	-	-	-	3	-	-	3
C227.4	3	3	2	3	-	-	-	-	3	-	-	3
C227.5	3	3	2	3	-	-	-	-	3	-	-	3
	3	3	2	3	-	-	-	-	3	-	-	2.6

CO – PSO Mapping

Electrical Machines - II LAB		
A14283	PSO1	PSO2
C227.1	3	-
C227.2	3	-
C227.3	3	-
C227.4	3	-
C227.5	3	-
	3	-

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STUDENT PERFORMANCE EVALUATION

TOTAL MARKS (75M)

EXTERNAL EVALUATION (50 Marks)

Circuit Diagram	10M
Procedure	10M
Experiment connections & observations	10M
Calculations	10M
Viva Voce	10M

INTERNAL EVALUATION (25 Marks)

Day to day evaluation	10M
Record	5M
Internal Exam	10M

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Rubrics for Electrical Machines I Laboratory

Total Marks: 15M

S. No.	Assessment Criteria	Excellent (80 – 100%)	Good (60-80%)	Average (Below 60%)
1	**Theoretical Knowledge to perform the experiment (2M)**	Student replied to all the questions posed by Laboratory teacher	Student replies to a minimum of 50% questions posed by the laboratory teacher	Student could not answer in the first session
2	**Preparation of list of equipment required (2M)**	Correctness in the rating and type of the equipment required	Correctness in the rating and type of equipment required with minor corrections	Student could not prepare the list of equipment required
3	**Making the circuit connections as per the circuit diagram. (3 M)**	Correctness of connections	Correctness of connections with minor corrections.	Unable to connect
4	**Performing the experiment and tabulating the values (3 M)**	Independent performance of the experiment with correct values	Performance of the experiment with teacher assistance	Unable to perform the experiment
5	**Record book (based on calculations, results, graphs) (5 M)**	Practical values matching with theoretical values/ Expected graph obtained.	Minor deviation in the practical values/ expected graph	Deviation of practical values with theoretical values / expected graph.

1. MAGNETIZATION CHARACTERISTICS OF A D.C. SHUNT GENERATOR

AIM: - To plot the open circuit characteristics of D.C Shunt generator and determine its critical field resistance and critical speed.

THEORY:

The performance of the electrical machines can be found out by their characteristic curves. The magnetization characteristics is also known as no-load saturation characteristic curves or open-circuit characteristic curves. It is drawn between no-load generated emf in armature (E_0) and the field current (I_f) at a given fixed speed. Its shape is practically same for all the generators.

Critical field resistance: Critical field resistance is the cut-off resistance beyond which the generator fails to generate emf. To find the critical resistance, draw a tangent to the O.C.C. curve from its initial position. The slope of the resistance curve gives the critical resistance.

Critical speed: Critical speed is the minimum speed below which the generator fails to build up the voltage. The critical speed of a generator can also be easily found from the O.C.C curves easily.

CIRCUIT DIAGRAM: -

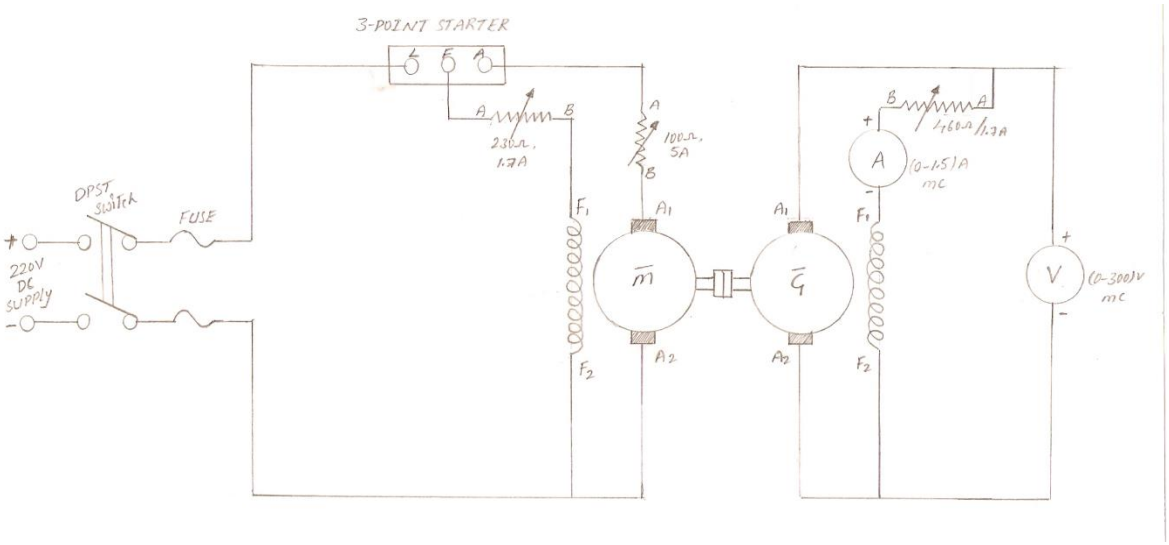


Fig 1.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeter	(0-1.5) A, MC	1
3	Rheostats	230Ω, 1.7A	2
		100Ω, 7A	1
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:	D.C Shunt Generator:
K.W:	K.W:
Voltage:	Voltage:
Current:	Current:
Speed:	Speed:
Excitation Current:	Excitation Current:
Excitation Voltage:	Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.

2. Keep armature rheostat of the Motor in maximum position and field rheostat of the motor in minimum position and also keep field rheostat of the generator in maximum position.

3. Switch 'ON' the D.C. supply and start the M-G set to rated value with the help of armature rheostat of the motor, If rated speed is not reached then adjust the field rheostat of the Motor.

4. Adjust the speed of the M-G set to rated value with the help of armature rheostat of the Motor, if rated speed is not reached then adjust the field rheostat of the Motor.

5. When M-G set rotates at rated speed a small reading is observed in the Voltmeter even though there is no current in the field winding. In this case note down the readings of Voltmeter and Ammeter.

6. Now, vary the field rheostat of the Generator in steps to rated voltage and at each step note the note down the readings of Voltmeter and Ammeter.

7. Switch 'OFF' the D.C. Supply of M-G set by making all devices to initial position.

NOTE: -

Speed of the M-G set is to be kept constant throughout the experiment and field rheostat of the Generator should be vary in only one direction till the rated voltage of the Generator.

PRECAUTIONS: -

- Connection should be neat and tight.
- Before starting of the M-G set check the rheostats positions properly.
- Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	E_g (Volts)	I_f (Amps)	Speed (r. p. m)

EXPECTED GRAPH: -

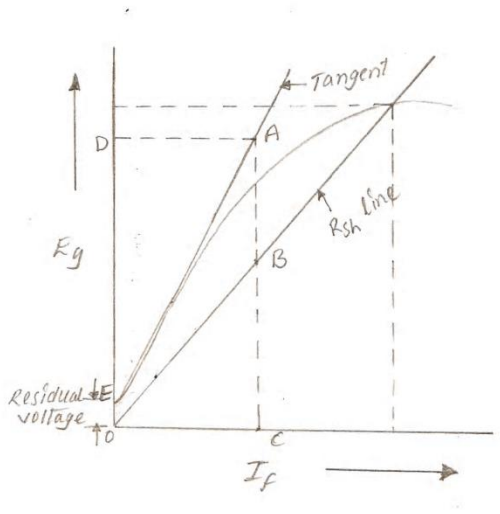


Fig 1.2

CALCULATIONS: -

Critical Resistance (R_c) = (E_g – OE) / I_f

Critical Speed ($Nc_)$ = N_s * (BC/AC)

RESULT: - Open Circuit Characteristics of DC Shunt generator are plotted and determined its critical field resistance and critical speed.

2. LOAD TEST ON D.C. SHUNT GENERATOR

AIM: - To perform load test on D.C Shunt generator and to determine its load characteristics

THEORY: -

The efficiencies of all D.C. machines can be computed in two ways:

1. Direct test
2. Indirect test

In direct method, the input and output power can be measured by suitable means and efficiency computed as a ratio of output to input.

A direct method is not used for large machines as:

a. It may not be possible to provide the necessary load.

b. Even if load is arranged, there would be enormous power loss during the test.

The performance of the electrical machines can be found out by their characteristic curves. The load test on D.C. compound generator is used to determine the load characteristics of the generator and also the change in efficiency when the load on the generator varies. The load characteristics are drawn between

1. Generated voltage (V_g) and Load current (I_{lg})
2. Efficiency and load current (I_{lg})

CIRCUIT DIAGRAM: -

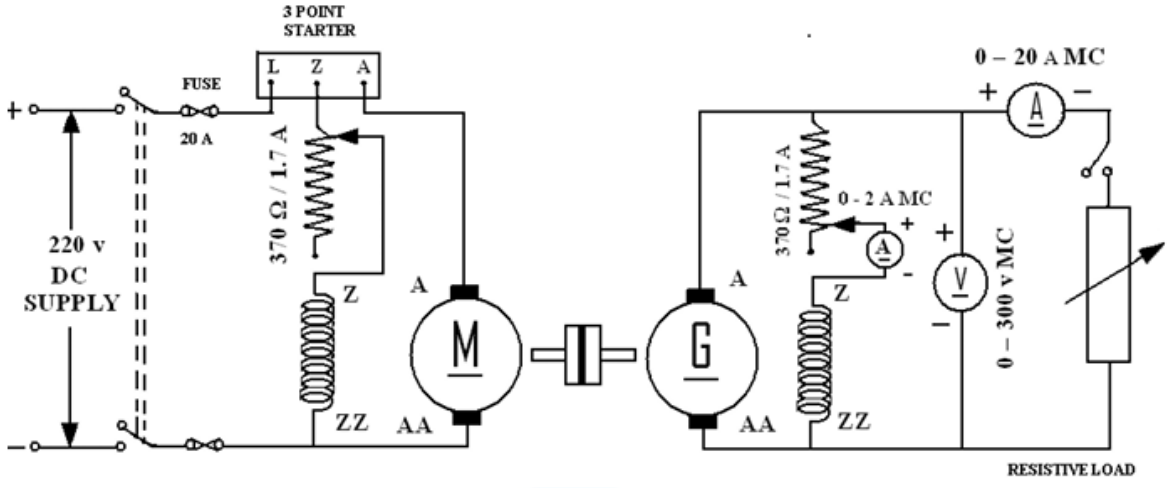


Fig 2.1

APPARATUS REQUIRED: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	2
2	Ammeters	(0-20) A, MC	2
		(0-1.5) A, MC	2
3	Rheostats	230Ω/1.7 A	2
		15 Ω/17.5 A	1
	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt motor	D.C Shunt Generator
KW:	KW:
Voltage:	Voltage:
Load Current:	Load Current:
Speed:	Speed:
Shunt field current	Shunt field current:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep field rheostat of the motor in minimum position and armature rheostat of the Motor in maximum position.
3. Switch 'ON' the D.C supply and start the M-G set with the help of 3-point starter.
4. Adjust the M-G set speed to rated value with the help of armature rheostat of the motor. If rated speed is not reached, then adjust the field rheostat of the motor.
5. Now, adjust the field rheostat of the generator to rated voltage of the generator.
6. Note down the No-load readings of Voltmeters & Ammeters.
7. Now, vary the load in steps to rated current of the generator and at each step note down the readings of voltmeters and Ammeters and also at each step maintain constant speed with the help of field rheostat of the motor.
8. Switch 'OFF' the load to zero position and also switch 'OFF' D.C. supply by making all devices to initial position.

NOTE: - Field rheostat of the generator should be varied in only one direction till the rated voltage of the generator is reached.

PRECAUTIONS: -

- Connections should be neat and tight
- Before starting of the M-G set ensure that there is no load on the Generator.
- Before starting of the motor check the rheostat positions properly.
- Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	V_M (V)	I_m (Amps)	V_g (V)	I_{Lg} (Amps)	I_{shg} (Amps)	I_{ag} (Amps)	IagRa (Volts)	Eg (Volts)	Input (Watts)	Output (Watts)	Efficiency % (η)

CALCULATIONS:

Armature current $(I_{ag}) = I_{Lg} + I_{shg}$

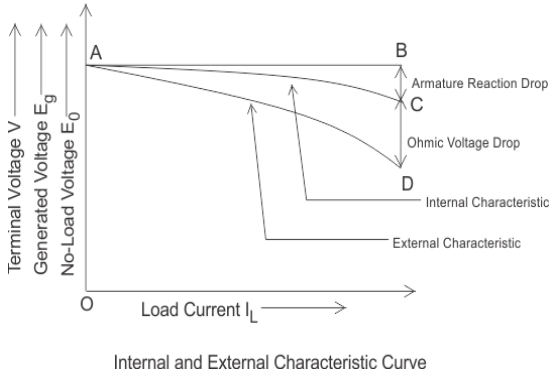
$E_g = V_g + I_{ag}R_a$

INPUT $= V_M * I_M$ Watts

OUTPUT $= V_g * I_{Lg}$ Watts

Efficiency = $\frac{\text{OUTPUT}}{\text{INPUT}} \times 100$

EXPECTED GRAPHS: -



Internal and External Characteristic Curve

Fig 2.2

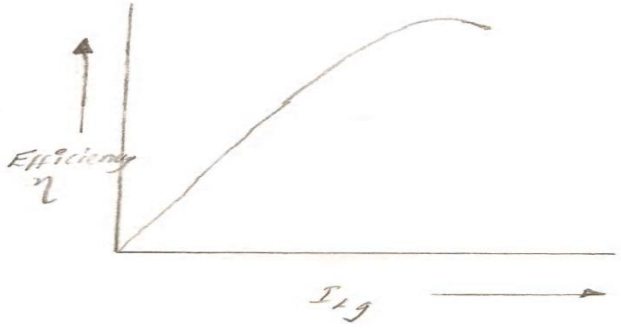


Fig 2.3

RESULT*:* - load test on D.C Shunt generator is performed and drawn its load characteristics.

3. LOAD TEST ON D.C. COMPOUND GENERATOR

AIM: - To perform load test on D.C Compound generator and to determine its load characteristics

THEORY:

The efficiencies of all D.C. machines can be computed in two ways:

1. Direct test
2. Indirect test

In direct method, the input and output power can be measured by suitable means and efficiency computed as a ratio of output to input.

A direct method is not used for large machines as:

a. It may not be possible to provide the necessary load.

b. Even if load is arranged, there would be enormous power loss during the test.

The performance of the electrical machines can be found out by their characteristic curves. The load test on D.C. compound generator is used to determine the load characteristics of the generator and the change in efficiency when the load on the generator varies. The load characteristics are drawn between Generated voltage (V_g) and Load current (I_{lg}), Efficiency and load current (I_{lg}).

CIRCUIT DIAGRAM: -

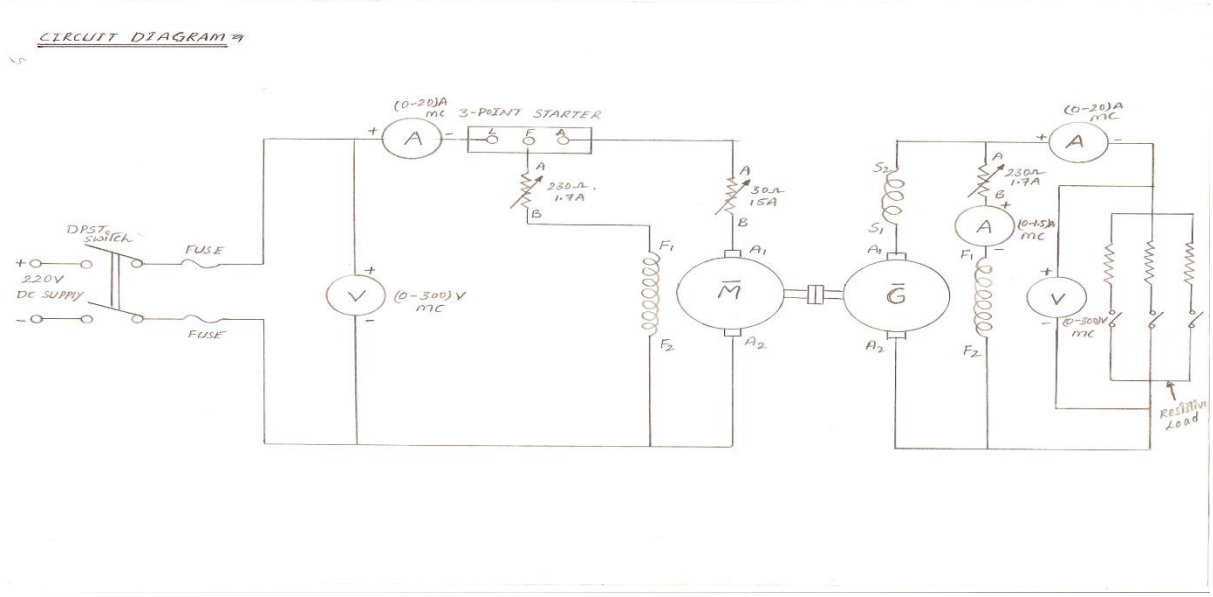


Fig 3.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	2
2	Ammeters	(0-20) A, MC	2
		(0-1.5) A, MC	2
3	Rheostats	230Ω/1.7 A	2
		15 Ω/17.5 A	1
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt motor

KW:
Voltage:
Load Current:
Speed:
Shunt field current

D.C Compound Generator

KW:
Voltage:
Load Current:
Speed:
Shunt field current:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE:

1. Connect the circuit as per the circuit diagram.
2. Keep field rheostat of the motor in minimum position and armature rheostat of the Motor in maximum position.
3. Switch 'ON' the D.C supply and start the M-G set with the help of 3-point starter.
4. Adjust the M-G set speed to rated value with the help of armature rheostat of the motor. If rated speed is not reached, then adjust the field rheostat of the motor.
5. Now, adjust the field rheostat of the generator to rated voltage of the generator.
6. Note down the No-load readings of Voltmeters & Ammeters.
7. Now, vary the load in steps to rated current of the generator and at each step note down the readings of voltmeters and Ammeters and at each step maintain constant speed with the help of field rheostat of the motor.
8. Switch 'OFF' the load to zero position and also switch 'OFF' D.C. supply by making all devices to initial position.

NOTE: - Field rheostat of the generator should be varied in only one direction till the rated voltage of the generator is reached.

PRECAUTIONS: -

a. Connections should be neat and tight

b. Before starting of the M-G set ensure that there is no load on the Generator.

c. Before starting of the motor check the rheostat positions properly.

d. Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	V_M (V)	I_m (Amps)	V_g (V)	I_{Lg} (Amps)	I_{shg} (Amps)	I_{ag} (Amps)	Iag(Ra+ R_{se}) (Volts)	Eg (Volts)	Input (Watts)	Output (Watts)	Efficiency (η) %

CALCULATIONS: -

Armature current $(I_{ag}) = I_{Lg} + I_{shg}$

$E_g = V_g + I_{ag}(R_a+R_{SE})$

INPUT $= V_M + I_M$ Watts

OUTPUT = $V_g I_{Lg}$ Watts

Efficiency = $\frac{\text{OUTPUT}}{\text{INPUT}} \times 100$

EXPECTED GRAPHS: -

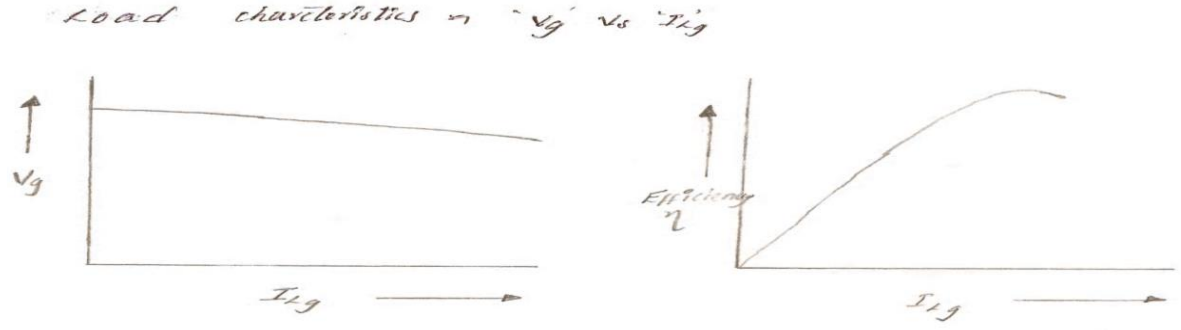


Fig 3.2

RESULT: - load test on D.C Compound generator is performed and drawn its load characteristics

4. LOAD TEST ON D.C. SERIES GENERATOR

AIM: - To perform Load test on D.C. Series Generator and determine its Internal and external characteristics.

THEORY: -

In a series-wound DC generator, the armature winding, field winding and external load circuit, all are connected in series with each other, therefore, the same current flows through all parts of the circuits.

Internal characteristics: -

If there would not have been demagnetizing effect of armature reaction, this curve would have given the total flux, when the machine is supplying current to the external load circuit, but due to armature reaction the actual curve lies somewhat below the magnetization curve, Since the emf generated in the armature is directly proportional to the actual flux at a constant speed, this curve also gives emf generated in the armature to some other scale. This curve is internal or total characteristic because it also gives relation between generated emf E_g and armature current I_a since $I_a = I_f$.

External or Load Characteristic: -

The load current, armature current and field current in series wound generator are the same. The terminal voltage of the generator is equal to the emf generated E_g less the voltage drops in armature and series field respectively. If R_a and R_{se} are the resistances of the armature and series field respectively and load current is I, then the voltage drop in armature and series field = $I(R_a + R_{se})$. This voltage drop for different values of load current may be represented by a straight-line OA. So if the ordinates of this ohmic drop line OA are deducted from those of internal characteristics, the relation between terminal voltage and load current, known as external characteristic, is obtained. From external characteristic it is observed that the terminal voltage first increases with the increase in load current, reaches the maximum value and finally decreases. If the load circuit resistance is reduced sufficiently, the terminal voltage may fall to zero. So if the series generator is operated on initial straight portion of the characteristic, it gives voltage approximately proportional to the current and if it is operated on dropping portion of the characteristic, it gives approximately constant irrespective of the external load circuit resistance.

CIRCUIT DIAGRAM:

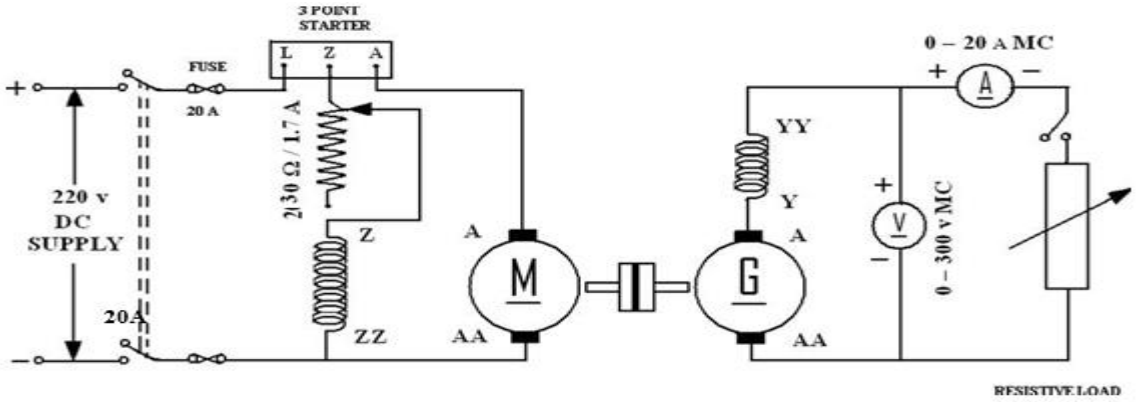


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Fig 4.1

APPARATUS REQUIRED: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	2
2	Ammeters	(0-20) A, MC	2
3	Rheostats	230Ω/1.7 A	2
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Current:
Speed:
Excitation Current:
Excitation Voltage:

D.C Series Generator:

K.W:
Voltage:
Current:
Speed:
Excitation Current:
Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep field rheostat of the motor in minimum position and armature rheostat of the Motor at maximum position.
3. Switch 'ON' the D.C supply and start the M-G set with the help of 3-point starter.
4. Adjust the M-G set speed to rated value with the help of armature rheostat of the motor. If rated speed is not reached, then adjust the field rheostat of the motor.
5. Note down the No-load readings of Voltmeters & Ammeters.
6. Now, vary the load in steps to rated current of the generator and at each step note down the readings of voltmeters and Ammeters and at each step maintain constant speed with the help of field rheostat of the motor.
7. Switch 'OFF' the load to zero position and also switch 'OFF' D.C. supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight.
- Before starting of the M-G set ensure that there is no load on the Generator.

OBSERVATION TABLE: -

S.NO	V_M (V)	I_{Lm} (Amps)	V_g (V)	$I_{Lg} = I_{ag} = I_{seg}$ (Amps)	$I_{ag}(R_a+R_{se})$ (Volts)	Eg (Volts)	Input (Watts)	Output (Watts)	Efficiency (η) %

CALCULATIONS: -

Armature current (I_{ag}) = I_{Lg} = I_{seg}

$$E_g = V_g + I_{ag}(R_a+R_{se})$$

Input Power = $V_M I_{Lm}$ Watts

Output Power = $V_g I_{Lg}$ Watts

$$\% \text{ Efficiency} = \frac{\text{Output Power}}{\text{Input Power}} * 100$$

EXPECTED GRAPHS: -

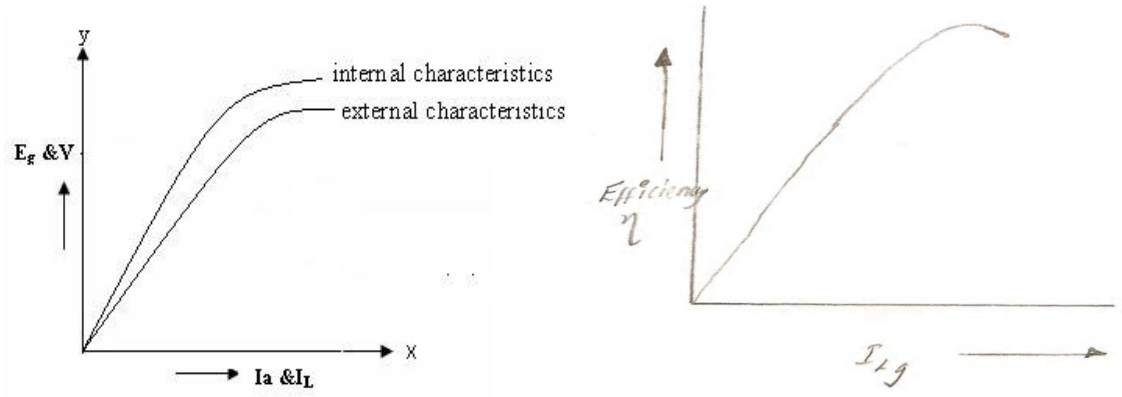

Fig 4.2

RESULT: - Load test is performed on D. C Series generator and determined its internal and external characteristics.

5. BRAKE TEST ON D.C COMPOUND MOTOR

AIM: - To perform brake test on D.C Compound Motor and plot its performance characteristics.

THEORY: - The efficiencies of all D.C. machines can be computed in two ways:

1. Direct test

2. Indirect test

In direct method, the input and output power can be measured by suitable means and efficiency computed as a ratio of output to input.

The brake test is a direct load test. The D.C. machine under test is a compound motor provided with a brake drum. There is a suitable arrangement for loading the motor mechanically.

The D.C. motor is started under no load, taking necessary precautions by applying rated voltage V_s. It is brought to its rated speed. It is then loaded. Loading is gradually increased, and for each load, ammeter, voltmeter, spring balance readings and speed are noted. Loading is continued till motor draws rated current from supply mains. The motor is shut down. By finding circumference, the radius of the brake drum is computed.

Input power= $V_S I_L$ Watts where V_S is the supply voltage in volts

I_L is the line current in amperes.

Output power= $(2\pi NT/60)$ Watts where N is speed in r.p.m.

T is Torque in N-m.

Efficiency= (output/input)

So, % efficiency of the motor= (output/input) *100

A direct method is not used for large machines as:

a. It may not be possible to provide the necessary load.

b. Even if load is arranged, there would be enormous power loss during the test.

CIRCUIT DIAGRAM: -

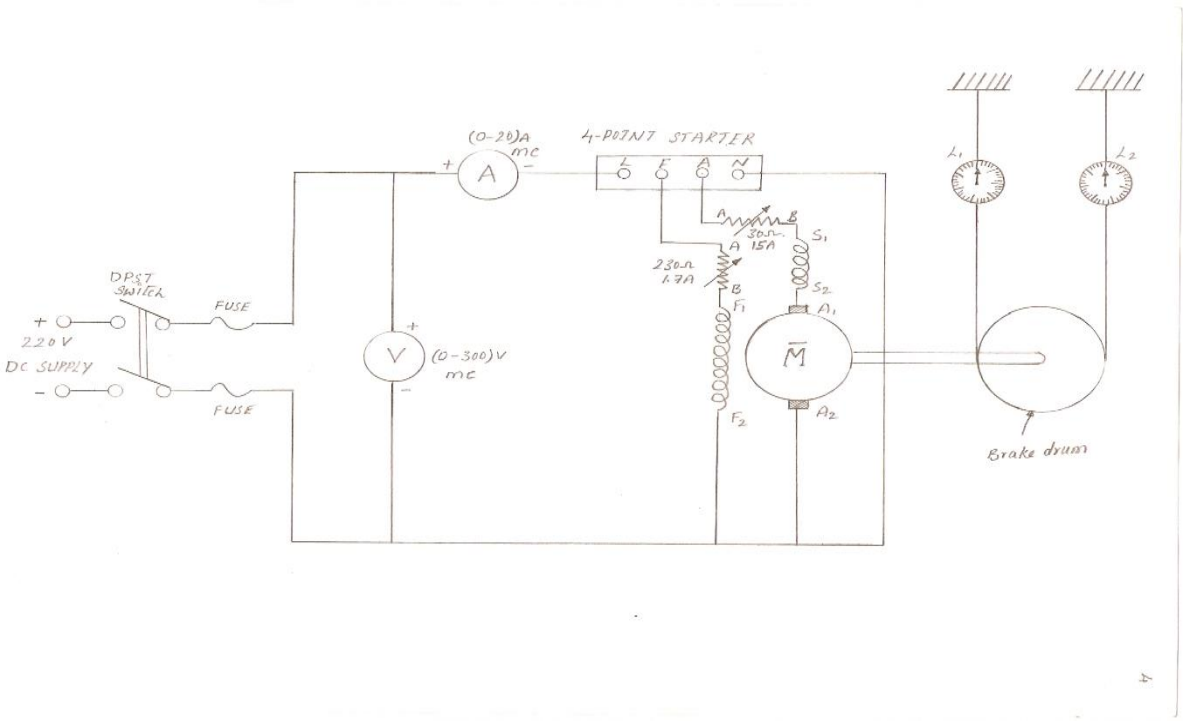

Fig 5.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-20) A, MC	1
3	Rheostats	230Ω/1.7 A	1
		6.1Ω, 17.5A	1
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Compound Motor:

K.W:
Voltage:
Current:
Speed:
Excitation Voltage:
Excitation Current:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep armature rheostat in maximum position and field rheostat at minimum position.
3. Switch ‘ON’ the D.C. supply and start the motor with the help of 4-point starter.
4. Now, adjust the motor speed to rated value, with the help of armature rheostat, if rated speed is not reached then adjust the field rheostat.
5. Note down the no-load readings of voltmeter, Ammeter, and also speed of the motor.
6. Now, vary the load in steps by using load arrangement to rated current of the motor and at each step note down the readings of voltmeter, Ammeter, loads and also speed of the motor.
7. Remove the load slowly to zero position and switch ‘OFF’ the D.C. supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight.
- Before starting of the motor water should be poured into brake drum.
- Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	Loads		Current I_L (Amps)	Voltage V (Volts)	Speed (N) (rpm)	Torque (T) (N-M)	Input (Watts)	Output (Watts)	η (%)
	L_1 (Kg)	L_2 (Kg)							

CALCULATION: -

Input = $V I_L$ watts

Torque = $9.81 * r * (L_2-L_1)$ N-M [r= radius of the Brake drum]

Output = $\frac{2\Pi NT}{60}$ watts

Efficiency = $\frac{\text{Output}}{\text{Input}}$ X 100

EXPECTED GRAPHS: -

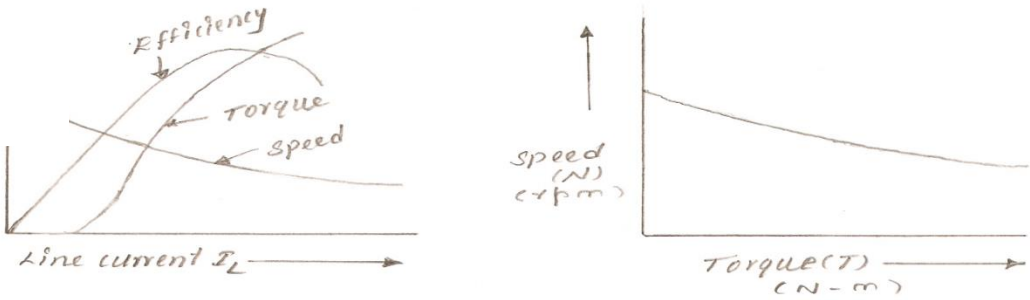

Fig 5.2

RESULT: - Brake test on D.C Compound Motor is performed and plotted its performance characteristics.

6. HOPKINSON'S TEST ON D.C. SHUNT MACHINES

AIM: - To perform Hopkinson's test on two identical D.C. Shunt machines and predetermine their efficiencies.

THEORY: It is also called as regenerative or back-to-back test. In this method, full-load test can be carried out on two shunt machines preferably identical ones without wasting their outputs. The two machines are mechanically and electrically coupled and are so adjusted electrically that one of them runs as a motor and the other runs as a generator. The mechanical output of the motor drives the generator, and the electrical output of generator is used in supplying the greater part of input to the motor.

ADVANTAGES:

1. Power required for the test is small as compared to the full load powers of the two machines.
2. As machines are being tested under full-load conditions, the temperature rise, and the commutation qualities of the machines can be observed.

The only disadvantage is regarding the availability of two identical machines.

CIRCUIT DIAGRAM: -

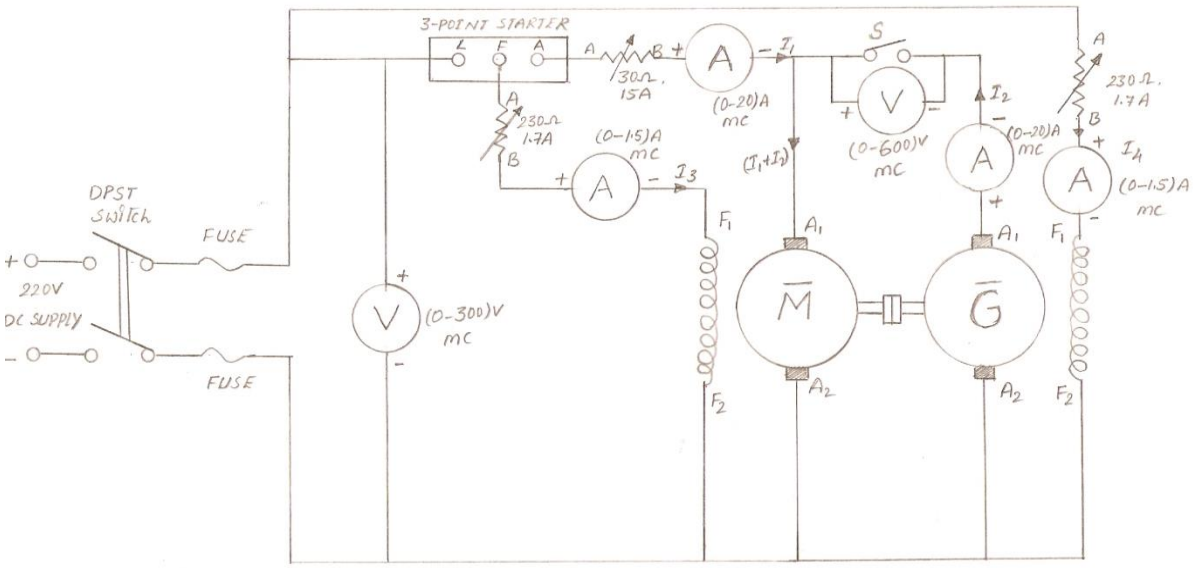

Fig 6.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
		(0-600) V, MC	1
2	Ammeters	(0-20) A, MC	2
		(0-1.5) A, MC	2
3	Rheostats	230Ω/1.7 A	2
		30 Ω/15 A	1
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt motor	D.C Shunt Generator
KW:	KW:
Voltage:	Voltage:
Load Current:	Load Current:
Speed:	Speed:
Excitation current	Excitation current:
Excitation Voltage:	Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep field rheostat of the motor in minimum position and armature rheostat of the motor in maximum position and keep field rheostat of the generator in maximum position.
3. Switch 'ON' the D.C. supply and start the M-G set with the help of 3-point starter.
4. Adjust the M-G set speed to rated value with the help of armature rheostat of the motor. If rated speed is not reached, then adjust the field rheostat of the motor.
5. Adjust the field rheostat of the generator till Voltmeter (V_1) reads zero volts.
6. When voltmeter 'V_1' reads zero volts close the Switch 'S'
7. Now, Increase the field current of the generator in steps with the help of field rheostat of the generator to rated current and at the same time decrease the field current of the motor with the help of field rheostat of the motor to maintain constant speed.
8. At each step note down the readings of voltmeter and Ammeter.
9. Switch 'OFF' the D.C. supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight
- Before starting of the M-G set check the positions of rheostats and also switch.
- Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	Voltage V (Volts)	Line Current (I_1) (Amps)	I_2 (Amps)	I_3 (Amps)	I_4 (Amps)	Stray Losses (Watts)	Generator Losses (Watts)	Motor losses (Watts)	Motor Input (Watts)	Generator output (watts)	η_M (%)	η_G (%)

I_1 = Line current

I_2 = Armature current of the Generator

I_3 = Shunt field current of the Motor

I_4 = Shunt field current of the Generator

CALCULATIONS: -

Motor Armature Copper Loss = $(I_1+I_2)^2 r_a$
Generator Armature Copper Loss = $I_2^2 r_a$

Power Drawn from The Supply = VI_1

Total Stray Losses for The Two Machines (W) = $VI_1 - [(I_1+I_2)^2 r_a + I_2^2 r_a]$

Stray Loss for Each Machine = W/2

MOTOR EFFICIENCY: -

Motor Input = $V(I_1+I_2) + VI_3$
Motor Losses = Armature copper losses + Shunt field copper losses + stray losses
$= (I_1+I_2)^2 R_A + VI_3 + W/2$

$$\eta_M = \frac{\text{Motor Input} - \text{Motor losses}}{\text{Motor input}}$$

GENERATOR EFFICIENCY: -

Generator Output = VI_2

Generator Losses = Armature copper loss + shunt field copper loss + stray losses

$$= I_2^2R_A + VI_4 + W/2$$

$$\eta_G = \frac{\text{Generator output}}{\text{Generator output + Generator losses}}$$

EXPECTED GRAPH: -

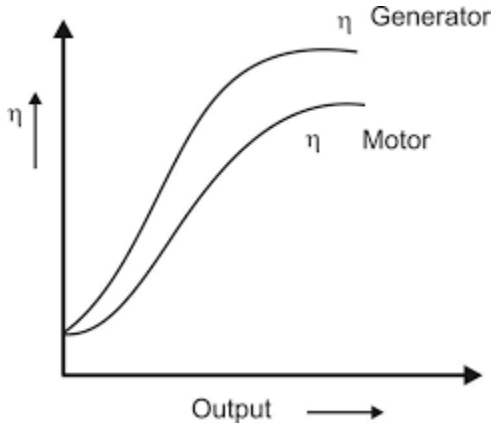

Fig 6.2

RESULT: - Hopkinson's test on two identical D.C. Shunt machines is performed and determined their efficiencies.

7. FIELD'S TEST ON DC SERIES MACHINES

AIM: - To determine the efficiency of the two DC series machines by conducting field's test.

THEORY: - Generally, Swinburne's test is the most popular testing method of dc machine to determine losses and efficiency. It is an indirect method of testing a dc machine performed without loading the machine. Since it is a no-load test, a series motor at no-load attains dangerously high speed. Hence, it is difficult to perform Swinburne's test on large series motors. Therefore, Swinburne's test is only applicable for dc shunt and small series machines. This drawback can be overcome by performing field test.

A field's test uses two similar dc series motors, which are mainly used for electric traction works. In field's test, two similar dc series machines with their field windings connected in series are used to determine losses and efficiency. The two machines are coupled mechanically in which one runs as a motor and the other as a generator driven by the motor. The electrical output from the generator is passed through variable load resistance R and dissipated as heat.
As they are rotating, they have frictional losses and constant losses. The iron and frictional losses of the two are made equal by, Exciting the machines equally, which is achieved by joining the series field winding of the generator with the motor armature circuit. Synchronizing the machines by running them at equal speed.

CIRCUIT DIAGRAM: -

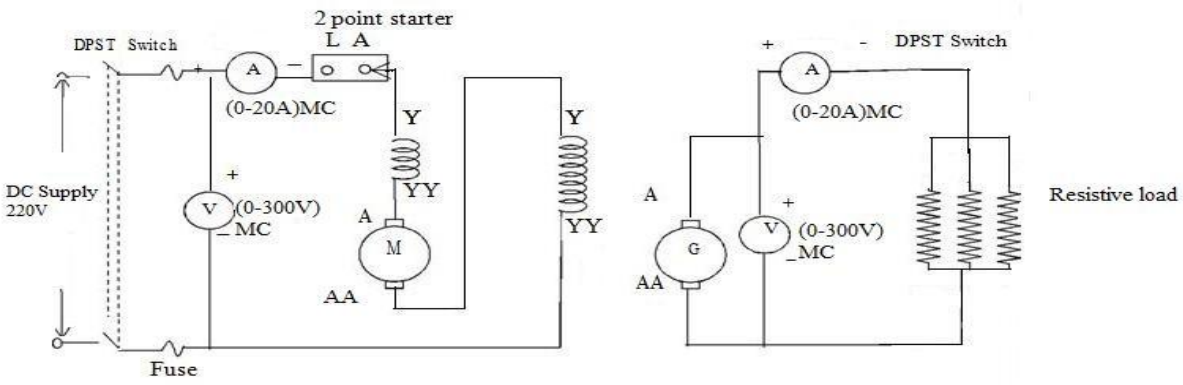

Fig 7.1

APPARATUS:

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	2
2	Ammeters	(0-20) A, MC	2
3	Rheostats	30 Ω/15 A	1
4	Tachometer	(0-9999) rpm	1
5	Resistive Load	5kW, 20 A	1

NAME PLATE DETAILS:

D.C Series motor	D.C Series Generator
KW:	KW:
Voltage:	Voltage:
Load Current:	Load Current:
Speed:	Speed:

FORMULAE: -

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_2I_2
Total losses in the set (W_T) = ($V_1 I_1 - V_2I_2$) =
Armature & Field copper losses (W_C) = ($R_a + 2 R_{se}$) $I_1^2 + I_2^2 R_a$ =
Stray Losses in Two Machines = ($W_T - W_C$) = W_S
Stray Losses for each Machine = $W_S / 2$

Motor Efficiency:

Motor Input = V_1I_1=
Motor Losses =I_1^2 (R_a + Rse) + W_S /2=
% Motor Efficiency = { [V_1I_1 - (I_1^2 (R_a + R_{se}) + C/2)] / V_1I_1 } * 100=

Generator Efficiency:

Generator output = V_2I_2=
Generator Losses =$I_1^2R_{se}$ + $I_2^2R_a$ + W_S /2 =
% Generator Efficiency = {V_2I_2 / [V_2I_2 + ($I_1^2R_{se}$+ $I_2^2R_a$ + W_S /2)]} * 100

Result: - Efficiencies of the two DC series machines are determined by conducting field's test on them.

8. SEPARATION OF LOSSES IN D.C SHUNT MOTOR

AIM: - To separate stray losses in a D.C. Shunt Motor.

THEORY: -

The various losses that occur in a D.C shunt machine are

Copper Losses: -

a) $I_a^2R_a$ the armature copper loss (30 to 40% of total full load losses)

b) Field copper losses $I_{sh}^2R_{sh}$ in a shunt winding (20 to 30% of total load losses)

c) Loss due to brush contact resistance.

Stray Losses: -

a) Iron Losses: Hysteresis loss and Eddy current loss (20 to 30% of total full load losses)

b) Mechanical Losses: Friction at bearing and commutator,
Windage of rotating armature (10 to 20% of full load losses)

Iron losses and mechanical losses are together called stray losses.

Iron Losses: - Iron losses are a function of both flux and speed.

Hysteresis Losses: - The hysteresis loss P_h is a measure of the electric energy required to overcome the retentivity of the iron in the magnetic flux path, using watts as unit,

$$P_h = K_h B^x f V$$

Where, V = volume of iron in dynamo subject to change of flux,

K_h = constant for the grade of iron employed,

B = flux density raised to the Steinmetz exponent. Which modern values of dynamo x is no longer 1.6 but closer to 2.0. This Is not to imply that for a given volume, V, of iron the loss has increased, because Kh has been reduced considerably, and

f = frequency (hz) of reversal of flux.

Eddy Current Losses: - These losses occur not only in the dynamo iron but in all conductive materials with the flux path of the rotating or varying magnetic field of the dynamo.The eddy current loss Pe in watts is,

$$P_e = K_e t^2 B^2 f^2 V$$

Where, K_e = an eddy current constant for the grade of iron employed,
t = thickness of the laminations of the pole core and armature
B = flux density
f = frequency (hz) of reversal of flux
V = volume of iron subject to change of flux.

For a D.C dynamo the frequency, f , reversal of flux varies with speed. Thus the hysteresis loss varies directly with speed, where as the eddy current loss varies as the square of speed. Both hysteresis loss and eddy current loss vary approximately as the square of the flux density. For this reason core losses are

considered a function of both flux and speed.

Mechanical (or friction) Losses:- When a machine is running, there are various frictional forces to be overcome, each of which requires a continuous expenditure of energy and results in heating the rubbed parts. There is friction loss in the machine bearings, at the surface of the commutator due to the rubbing of the brushes, and in the armature core due to its fanning action. These losses depend upon the speed but are independent of the load on the machine. They are difficult to estimate by direct calculation but may be found by measurement.

CIRCUIT DIAGRAM: -

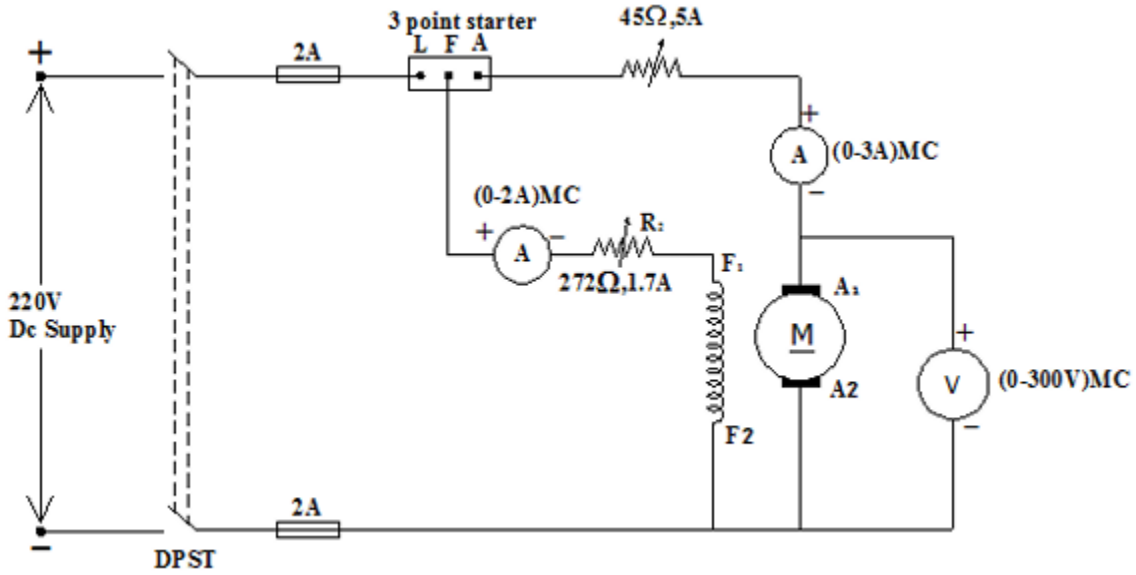

Fig 8.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-1.5) A, MC	1
		(0-3) A, MC	1
3	Rheostats	230Ω/1.7 A	2
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Current:
Speed:
Excitation Voltage:
Excitation Current:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep armature rheostat in maximum position and field rheostat at minimum position.
3. Switch 'ON' the D.C supply and start the Motor with the help of 3-point starter.
4. Adjust the speed of the Motor to rated value with the help of armature rheostat, if rated speed is not reached then adjust the field rheostat.
5. note down the readings of voltmeter, ammeters and speed of the motor.
6. Keep field current constant at normal value and vary the speed of motor in steps to lower value say 650 rpm with the help of armature rheostat.
7. At each step note down the readings of voltmeter, ammeters and speed of the motor.
8. Now, again bring the motor speed to rated value with the help of armature rheostat and keep field current constant at ¾ th of normal value and note down the readings of voltmeter, ammeters and speed of the motor.
9. Vary the speed of motor in steps to lower value say 650 rpm with the help of armature rheostat and at each step note down the readings of voltmeter, ammeters and speed of the motor.
10. Switch 'OFF' the D.C Supply by making all devices to initial position

PRECAUTIONS: -

- Connections should be neat and tight.
- Note down the readings without any parallax error.
- Before starting of the Motor check the rheostat position properly.

OBSERVATION TABLE: -

At Normal field current (I_{f1} = A)

S.No	E_b (Volts)	I_a (Amps)	N (RPM)	W_S (Watts)	$\frac{W_S}{N}$	W_h (Watts)	W_e (Watts)	W_f (Watts)	W_w (Watts)

At ¾ th of Normal field current (I_{f2} = A)

S.No	E_b (Volts)	I_a (Amps)	N (RPM)	W_S (Watts)	$\frac{W_S}{N}$	W_h' (Watts)	W_e' (Watts)	W_f (Watts)	W_w (Watts)

CALCULATIONS: -

Stray losses (W_S) = E_b Ia

At Normal Field Current:

Hysteresis loss (W_h) $\propto (\Phi)^{1.6}$ N

W_h = AN ('Φ' = Constant)

Eddy Current loss (W_e) $\propto (\Phi)^2 N^2$

$W_e = BN^2$ ('Φ' = Constant)

Iron losses (W_i) = $W_h + W_e$

$W_i = AN + BN^2$

Friction loss (W_f) $\propto$ N

W_f = CN

Windage loss (W_w) $\propto N^2$

$W_w = DN^2$

Mechanical losses (W_m) = $W_f + W_w$

$$W_m = CN + DN^2$$

Stray losses (W_S) = $W_i + W_m$

$W_S = AN + BN^2 + CN + DN^2$

$= (A + C) N + (B + D) N^2$

$(W_S / N) = (A + C) + (B + D) N$ --------- At Normal field current

At ¾ th of Normal Field Current:

$W_h' = A'N$

$W_e' = B'N^2$

$W_f = CN$

$W_w = DN^2$

$W_S = A' N + B' N^2 + CN + DN^2$

$W_S / N = (A' + C) + (B' + D) N$ ---------- At ¾ th of Normal field current

$A/A' = (\Phi/ \Phi')^{1.6} = (I_{f1}/ I_{f2})^{1.6}$ ---------- (1)

$B/B' = (\Phi/ \Phi')^2 = (I_{f1}/ I_{f2})^2$ ---------- (2)

Determine (A + C), (A′ + C), (B + D) and (B′ + D) from the graph.

Determine A, B, C, D, A′ and B′ constants using eq-1, eq-2, and with above determined values.

EXPECTED GRAPHS: -

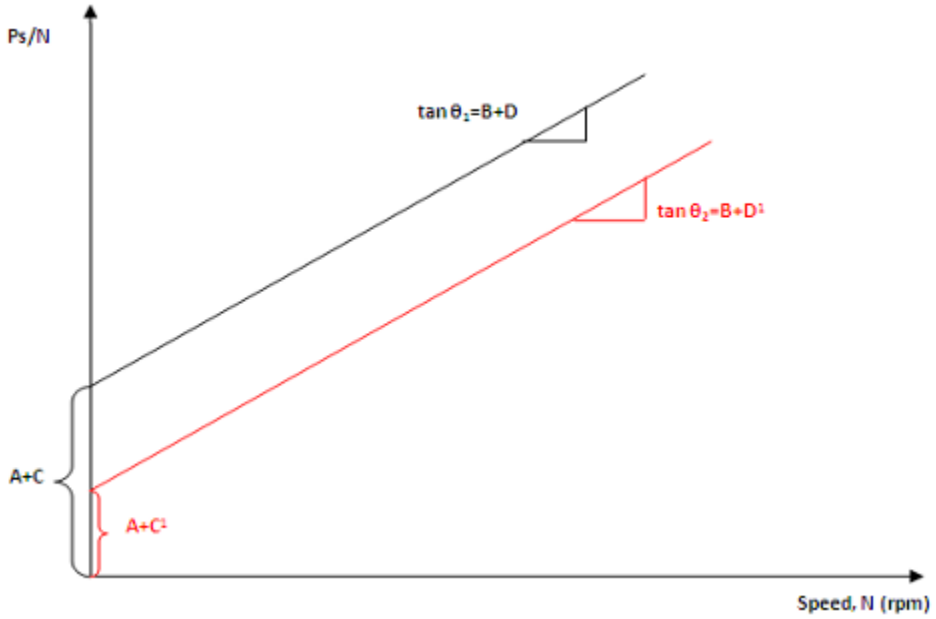

Fig 8.2

RESULT: - Stray losses are separated in a D.C. Shunt Motor.

9. RETARDATION TEST ON DC SHUNT MOTOR

AIM: - To separate the mechanical and iron losses of the given dc shunt machine.

THEORY: -

Another name for this test is running down test. In this method of testing, firstly motor is speeded up slightly above its rated speed and supply is cut off. Then starting the stopwatch till the speed come to below the rated speed. Speed time curve is drawn for various values of speed to obtain rate of change of speed. Secondly, by attaching flywheel of known moment of inertia to motor taking the reading for various values of speed to draw the speed time curve to obtain rate of change of speed, then by calculating moment of inertia of motor rotational losses can be found.

CIRCUIT DIAGRAM: -

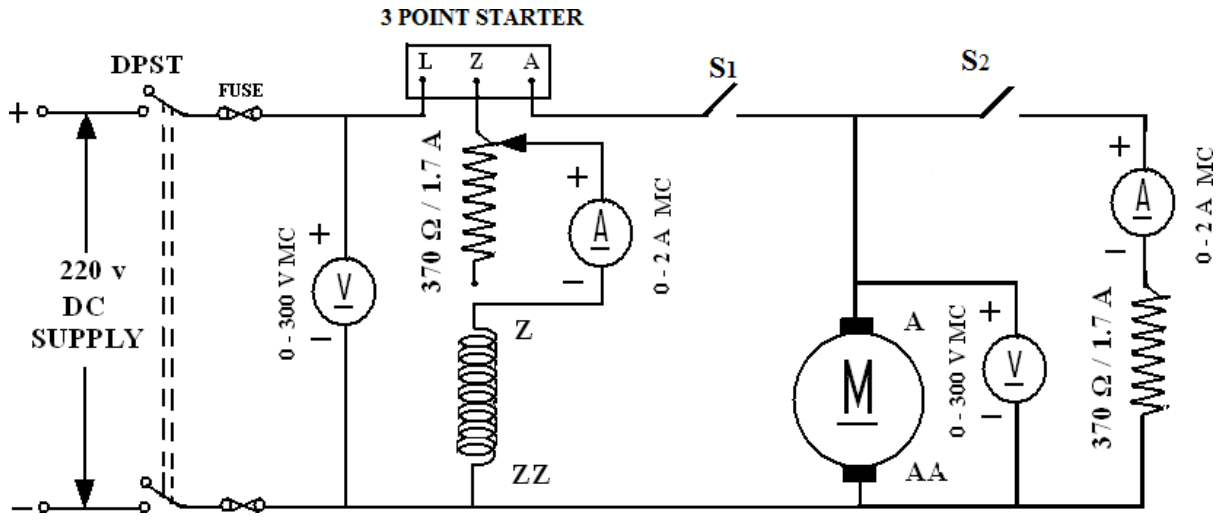

Fig 9.1

APPARATUS REQUIRED: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-2) A, MC	2
3	Rheostats	370Ω/1.7 A	2
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Current:
Speed:
Excitation Current:
Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connections are made as per the circuit diagram.
2. Initially the switch S_2 is open and S_1 is closed then the motor is started with the help of three point starter.
3. The speed is adjusted to just above the rated speed by adjusting the field rheostat.
4. The voltage is noted then switch S_1 is opened and note down the time taken to reach the armature voltage to a voltage of 25% less than the initial value.
5. Again S_1 is closed immediately before the motor reaches to zero speed and rheostats are adjusted until the motor reaches its rated speed.
6. Then S_1 is opened and at a time S_2 is closed at this instant record the readings of ammeter and also note down the time taken to reach the armature voltage to a voltage of 25% less than the initial voltage.

PRECAUTIONS: -

1. Take care while using the starter.
2. The speed should be adjusted to rated speed.
3. There should be no loose connections.

OBSERVATION TABLE: -

S_1 close and S_2 open

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

S_1 open at a time S_2 close

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

CALCULATIONS: -

Rotational losses or stray losses $P_S = P_1 (t_2 / t_2 - t_1)$

$P_S^1 = V_{avg} * I_{Lavg}$

Input power = $V I_L$

I_L = full load current of the motor Armature cu losses = Ia^2Ra

$Ia = I_L - I_f$

Total losses = Armature cu losses + Stray losses Output power = Input - Total losses

Motor efficiency ή = output/input.

RESULT: - mechanical and iron losses are separated for a given dc shunt machine.

10. SPEED CONTROL OF D.C SHUNT MOTOR

AIM: - To study the variation of speed of a D.C Shunt motor by varying Voltage across the armature and shunt field current.

THEORY:

For a given motor, the factors which influence the speed of the motor are applied voltage, armature resistance and field current (or) flux per pole. So, there are three methods of speed control-

a. Voltage control method

b. Armature control method

c. Flux control method

ARMATURE CONTROL METHOD:

This method is also termed as Rheostatic control method. In this method, resistance of armature circuit is varied by introducing a variable resistance into the armature circuit.

With the variable resistance R fully cut in, it is observed that the speed is minimum. When R is maximum, there is maximum voltage drop across it and voltage across the motor armature is minimum. Hence, speed is minimum.

As R is cut put, more voltage gets applied across armature, and speed progressively increases. When R is fully cut out, the rated voltage V gets applied across the armature and motor would attain its rated no-load speed.

In this method, only speeds below the rated speed can be obtained. The demerit of this method is that there is considerable power loss as long as R is in the armature circuit.

FIELD CONTROL METHOD:

In this method of speed control, a variable resistance is incorporated in the field circuit. With the resistance R fully cut out, the speed is minimum (equal to rated speed) since field current is maximum and maximum flux is produced.

As resistance R is cut in more and more, less and less current flows through field windings. Hence, flux decreases more and more, with the result that speed increases progressively.

In this method, only speeds above the rated speed can be obtained. The power loss due to R is quite small since field current is generally small.

CIRCUIT DIAGRAM: -

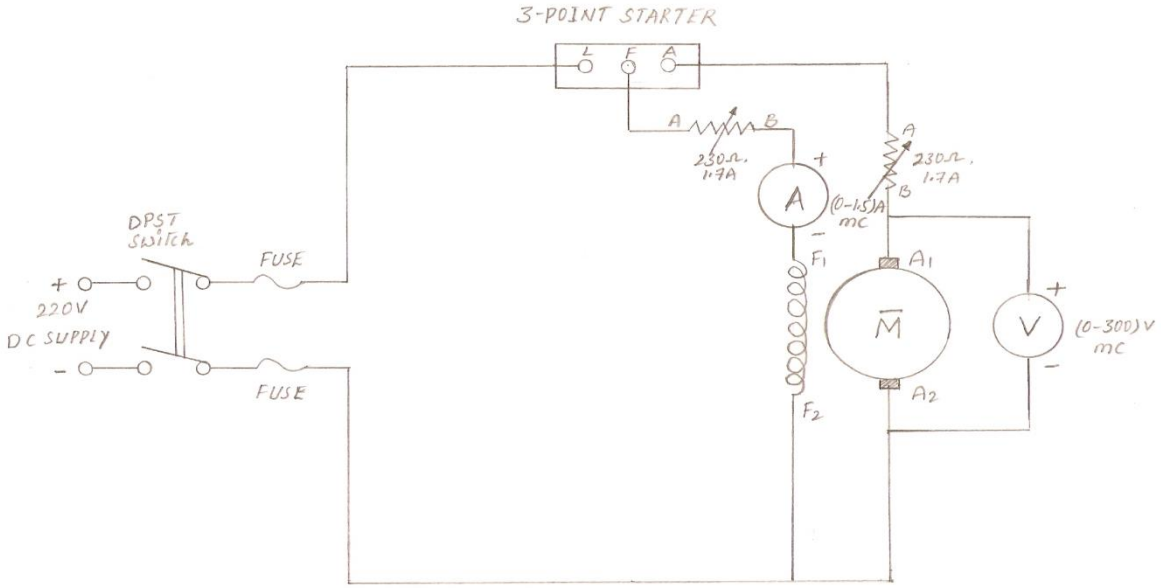

Fig 10.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-1.5) A, MC	1
3	Rheostats	230Ω/1.7 A	2
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Current:
Speed:
Excitation Current:
Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep armature rheostat in maximum position and field rheostat in minimum position.
3. Switch 'ON' the D.C supply and start the Motor with the help of 3-point starter.
4. Adjust the speed of the Motor to rated value with the help of armature rheostat, if rated speed is not reached then adjust the field rheostat.

Armature control method: -

- In armature control method keep shunt field current constant and vary the voltage across armature in steps to 1200 r.p.m with the help of armature rheostat.
- At each step note down the readings of speed and voltage across armature (E_b).

Field control method: -

- In field control method bring the Motor speed to rated value and keep the voltage across armature constant.
- Now, vary the shunt field current in steps to 1800 r.p.m with the help of field rheostat and at each step note down the readings of speed and shunt field current.
- Switch 'OFF' the D.C supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight.
- Note down the readings without any parallax error.
- Before starting of the Motor check the rheostat position properly.

OBSERVATION TABLE: -

ARMATURE CONTROL METHOD (I_f = constant)

S.NO	E_b (VOLTS)	SPEED(N) (RPM)

FIELD CONTROL METHOD **(E_b = constant)**

S.NO	Field current (I_f) (AMPS)	SPEED(N) (RPM)

EXPECTED GRAPHS: -

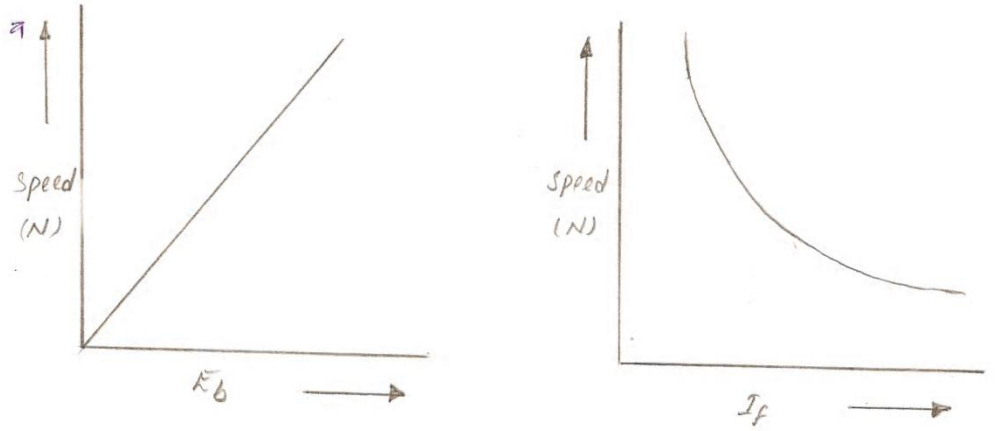

Fig 10.2

RESULT: - Variation of speed of a D.C Shunt motor is studied by armature control and shunt field current methods.

11. SWINBURNE'S TEST ON D.C SHUNT MACHINE

AIM: - To perform Swinburne's test on D.C Shunt Motor and predetermine the efficiency of a D.C. Shunt machine when it is working as a Motor and as a Generator.

THEORY:

Swinburne's test or no-load test is a simple method in which losses are measured separately and from their knowledge, efficiency at any desired load can be predetermined in advance. However, this test is applicable to those machines in which flux is practically constant i.e. shunt and compound-wound machines. The machine is run as a motor on no load at its rated voltage and rated speed. The speed is adjusted with the help of shunt regulator and note the reading of no load armature and shunt field current. The load line current

$$I_L = I_a - I_{sh} \text{ for generator}$$
$$I_L = I_a + I_{sh} \text{ for motor.}$$

This test is convenient and economical because power required to test a large machine small i.e. only no load input power. In this test, since constant losses are known. The efficiency of the D.C. machine can be predetermined at any load.

CIRCUIT DIAGRAM: -

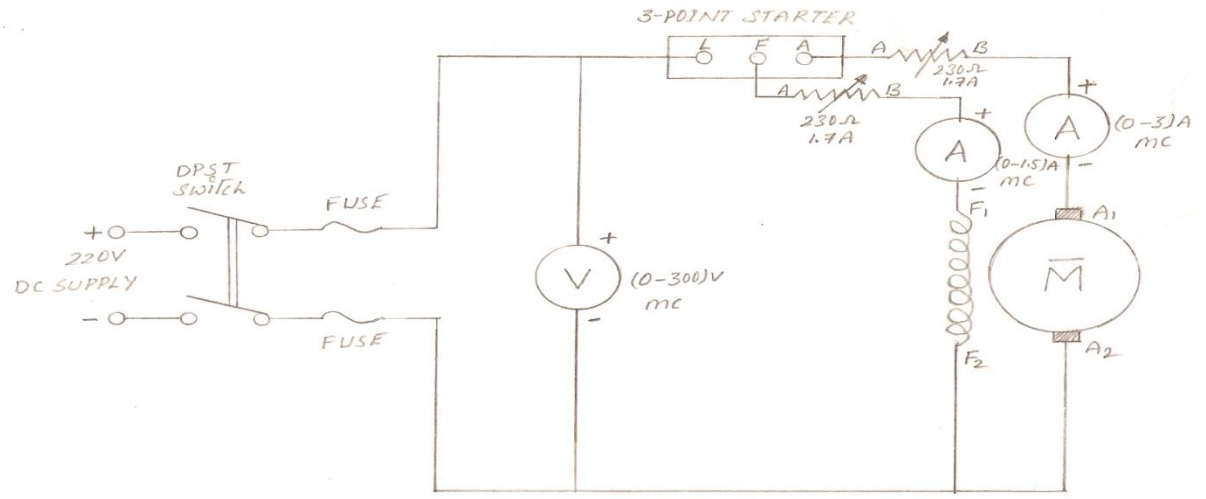

Fig 11.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-3) A, MC	1
		(0-1.5) A, MC	1
3	Rheostats	230Ω/1.7 A	2
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Load Current:
Speed:
Excitation Current:
Excitation Voltage:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram as shown in fig.
2. Keep armature rheostat in maximum position and field rheostat at minimum position.
3. Switch 'ON' the D.C supply and start the motor with the help of 3-point starter.
4. Adjust the speed of the Motor to rated value with the help of armature rheostat, if rated speed is not reached then adjust the field rheostat.
5. Note down the no-load readings of voltmeter and ammeters.
6. Switch 'OFF' the D.C. supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight
- Before starting of the motor ensure that there is no-load on the motor and also check rheostat position properly.
- Note down the readings without any parallax error.

OBSERVATION TABLE: -

No-load Readings: -

V =
I_{a0} =
I_{Sh} =

CALCULATION: -

No-load Input = VI_{L0} ($I_{L0} = I_{a0} + I_{sh}$)

No-load Armature cu.loss = $I_{ao}^2R_a$

Constant losses (Wc) = $VI_{L0} - I_{a0}^2R_a$

As a Motor: -

Load input = X V I_L [Where, x = load factor]

Armature cu.loss = $I_a^2R_a$

$I_a = XI_L - I_{sh}$

Total losses = $W_c + I_a^2R_a$

$\eta_M = \frac{\text{Input} - \text{Total losses}}{\text{Input}} * 100$

S.No	I_L (Amps)	V (V)	I_{Sh} (Amps)	I_a (Amps)	$I_a^2R_a$ (Watts)	Total Losses (Watts)	Input (Watts)	Output (Watts)	η (%)

As a Generator: -

Load Output = X VI_L [Where, x = load factor]

Armature cu.loss = $I_a^2R_a$

Ia = $XI_L + I_{sh}$

Total losses = $W_c + I_a^2R_a$

$\eta_G = \frac{\text{Output}}{\text{Output} + \text{Total losses}} * 100$

S.No	I_L (Amps)	V (V)	I_{Sh} (Amps)	I_a (Amps)	$I_a^2R_a$ (Watts)	Total Losses (Watts)	Input (Watts)	Output (Watts)	η (%)

EXPECTED GRAPHS: -

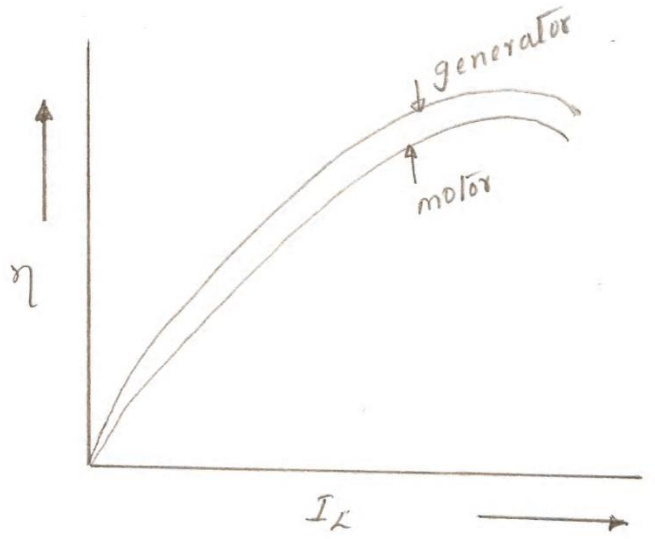

Fig 11.2

RESULT: - Swinburne's test on D.C Shunt Motor is performed and predetermine the efficiency of a D.C. Shunt machine when it is working as a Motor and as a Generator.

12. BRAKE TEST ON D.C SHUNT MOTOR

AIM: - To perform brake test on D.C Shunt Motor and draw its performance characteristics.

THEORY: The efficiencies of all D.C. machines can be computed in two ways:

a. Direct test

b. Indirect test

In direct method, the input and output power can be measured by suitable means and efficiency computed as a ratio of output to input.

The brake test is a direct load test. The D.C. machine under test is a shunt motor provided with a brake drum. There is a suitable arrangement for loading the motor mechanically.

The D.C. motor is started under no load, taking necessary precautions by applying rated voltage V_s. It is brought to its rated speed. It is then loaded. Loading is gradually increased, and for each load, ammeter, voltmeter, spring balance readings and speed are noted. Loading is continued till motor draws rated current from supply mains. The motor is shut down. By finding circumference, the radius of the brake drum is computed.

Input power= $V_S I_L$ Watts where V_S is the supply voltage in volts

I_L is the line current in amperes.

Output power= $(2\pi NT/60)$ Watts where N is speed in r.p.m.

T is Torque in N-m.

Efficiency= (output/input)

So, % efficiency of the motor= (output/input) *100

A direct method is not used for large machines as:

1. It may not be possible to provide the necessary load.

2. Even if load is arranged, there would be enormous power loss during the test.

CIRCUIT DIAGRAM: -

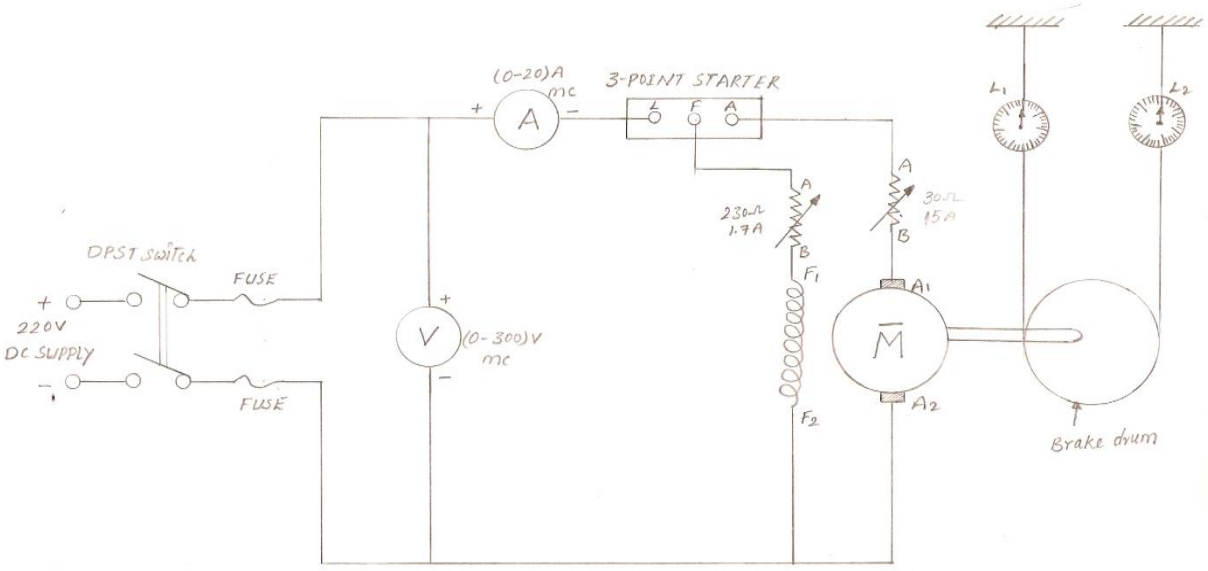

Fig 12.1

APPARATUS: -

S No	Apparatus	Range	Quantity
1	Voltmeter	(0-300) V, MC	1
2	Ammeters	(0-20) A, MC	1
3	Rheostats	230Ω/1.7 A	1
		6.1Ω, 17.5A	1
4	Tachometer	(0-9999) rpm	1

NAME PLATE DETAILS: -

D.C Shunt Motor:

K.W:
Voltage:
Load Current:
Speed:
Excitation Voltage:
Excitation Current:

FUSE RATING CALCULATIONS: -

For No-Load: 10% of rated current of motor:

For Full-Load: 125 % of rated current of motor:

PROCEDURE: -

1. Connect the circuit as per the circuit diagram.
2. Keep armature rheostat in maximum position and field rheostat at minimum position.
3. Switch 'ON' the D.C supply and start the motor with the help of 3-point Starter.
4. Now, adjust the motor speed to rated value with the help of armature rheostat, if rated speed is not reached then adjust the field rheostat.
5. Note down the no-load readings of input voltage and line current and speed of the motor.
6. Now, vary the load in steps by using load arrangement to rated current of the motor and at each step note down the readings of the voltmeter, Ammeter, loads and speed of the motor.
7. Remove the load slowly to zero position and switch 'OFF' D.C Supply by making all devices to initial position.

PRECAUTIONS: -

- Connections should be neat and tight.
- Before starting of the motor water should be poured into Brake drum.

- Note down the readings without any parallax error.

OBSERVATION TABLE: -

S.NO	Load		Current I_L (Amps)	Voltage V (Volts)	Speed (N) (rpm)	Torque (T) (N-M)	Input (Watts)	Output (Watts)	η (%)
	L_1 (Kg)	L_2 (Kg)							

CALCULATION: -

Input = V * I_L Watts

Torque = 9.81 * r * (L_2-L_1) N-M [r= radius of the Brake drum]

Output = (2ΠNT) / 60 watts

% Efficiency = (Output / Input) * 100

EXPECTED GRAPHS: -

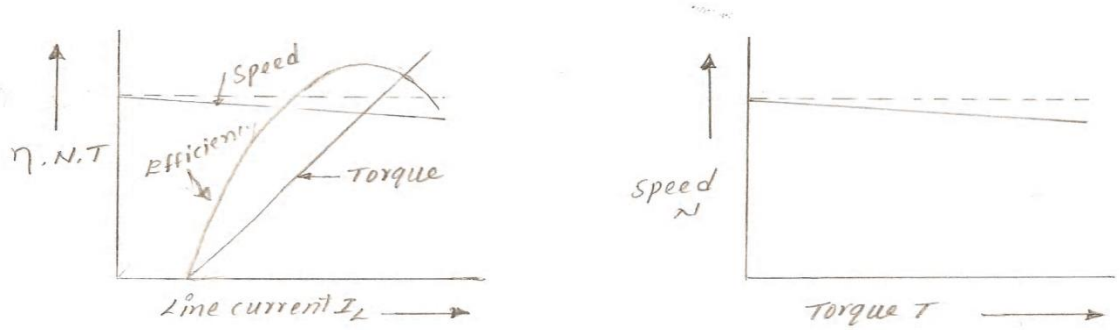

Fig 12.2

RESULT: - Brake test on D.C Shunt Motor is performed and plotted its performance characteristics.

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PRACTICAL RECORD BOOK

Academic year 2021 -2022

Name: G. Kalyan

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Course: B.Tech Year/Sem II year I Sem

Subject: EM-I Lab

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Name of the College: Vidya Jyothi Institute of Technology

Certificate

This is to certify that the bonafide record of the practical work carried out by

Mr/~~Miss~~ G. Kalyan *Roll No.* 19911A0229

of Class 2nd year 2nd Sem *in the* Electrical Machines-I Lab

laboratory during the academic year 2020 - 2021

Faculty In-charge *Head of the Dept.* *External Examiner*

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Department of Electrical and Electronics Engineering (Accredited by NBA)

LAB ASSESSMENT

Name of the Laboratory: Electrical Machines-I **Branch/Section: A** **Year/Sem: II-II** **Page:**

S.No	Roll Number	Day to Day Assessment – Week																Day To Day Assessment	Record (5) Marks	Internal Exam (10) Marks	Total Marks 25
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16				
21	19911A0222	10	10	10	10	10	9	10	9	10	10							10	4	10	24
22	19911A0223	9	9	8	10	9	9	9	8	10	9							9	5	10	24
23	19911A0224	5	7	7	5	6	6	6	6	6	6							6	4	08	18
24	19911A0225																				
25	19911A0226	9	10	9	8	9	9	9	9	9	9							9	5	10	24
26	19911A0227	8	10	8	7	8	7	8	8	8	8							8	4	09	21
27	19911A0228	9	9	9	9	9	9	8	9	10	9							9	5	10	24
28	19911A0229	9	10	9	8	9	9	9	9	9	9							9	4	09	22
29	19911A0230	7	5	5	7	6	6	6	6	6	6							6	4	08	18
30	19911A0231	10	10	9	10	10	10	9	10	10	10							10	4	10	24
31	19911A0232	10	9	9	9	8	9	9	9	9	9							9	5	10	24
32	19911A0233	9	9	9	9	8	9	9	9	9	10							9	4	09	22
33	19911A0234	9	8	7	8	8	8	8	8	8	8							8	4	09	21
34	19911A0235	10	9	8	9	9	9	9	9	9	9							9	4	09	22
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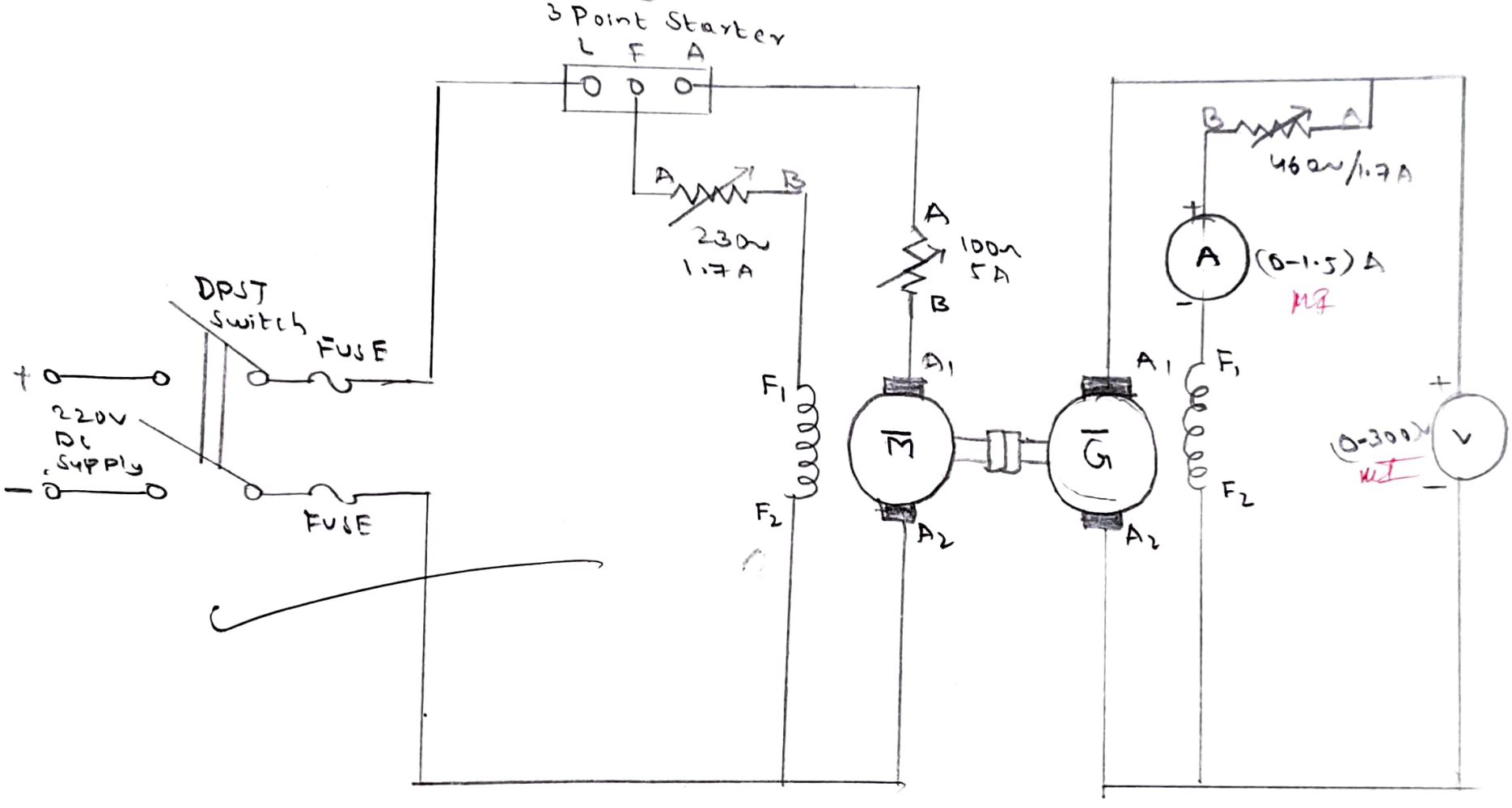
40	19911A0241	9	9	9	9	10	8	9	9	9	9							9	5	09	23

Circuit Diagram:



Title : Magnetization Characteristics of DC Shunt Generator :

Date : 3/8/24

Page No. : 2

Aim:

To plot the Open Circuit Characteristics of DC Generator and also determine its Critical Field resistance and Critical Speed.

Apparatus Required:

1.	Voltmeter	(0-300)V	MC 2 NO's
2.	Ammeter	(0-1.5)A	MC 1 NO
3.	Rheostat	230Ω, 1.7 A	2 NO's
		100Ω, 7A	1 NO
4.	Tachometer	Analog/Digital	1 NO

Name Plate Details :

DC Shunt Motor :

K.W : 5.2

Voltage : 220V

Current : 27.5 A

Speed : 1500 rpm

Excitation Current : 0.85 A

Excitation Voltage : 220 V

DC Shunt Generator :

K.W : 3.7

Voltage : 220 V

Current : 16.8 A

Speed : 1500 rpm

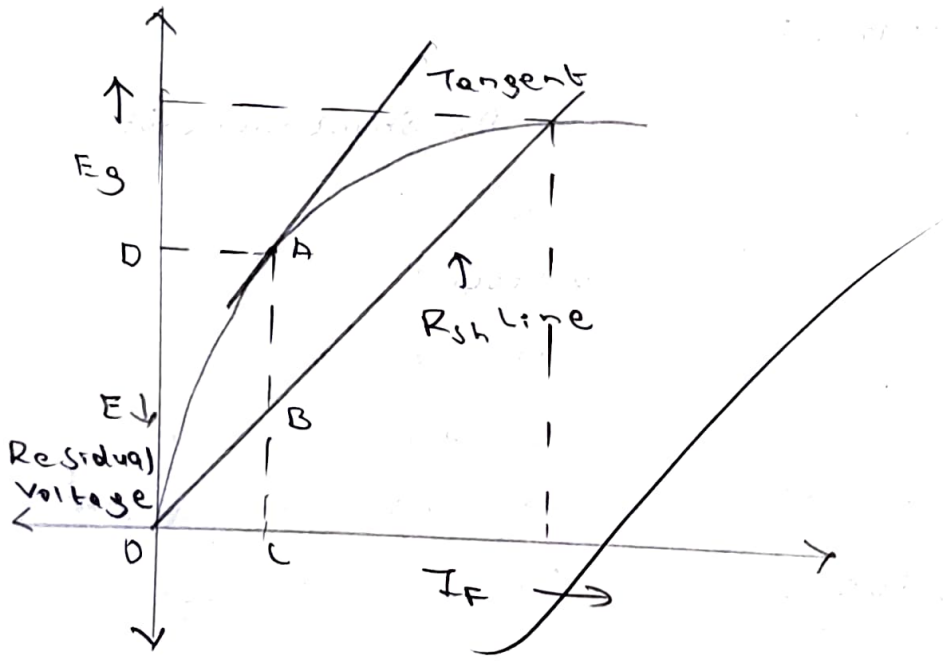
Excitation Current : 0.92 A

Excitation Voltage : 220 V

Tabular Column:

S.NO	Eg(Volts)	I_F (amps)	Speed(rpm)
1.	8x2	0.02	1500
2	20x2	0.1	1500
3	40x2	0.2	1500
4.	60x2	0.3	1500
5	80x2	0.44	1500
6	110x2	0.6	1500

Expected Graph:



Theory:

The performance of the electrical machines can be found out by their characteristic curves. The magnetization is also known as noload Saturation characteristic curves. It is drawn between no-load generated emf in armature (E_0) and the Field Current (I_f) at given Fixed Speed.

Critical Field Resistance: It is the cutoff resistance beyond which the generator fails to generate emf. To find the Critical Resistance draw a tangent to the OCC curve from its initial position. The Slope of the resistance curve gives the Critical resistance.

Critical Speed: Critical Speed is the minimum speed below which the generator fails to buildup the voltage. The Critical Speed of a generator can also be easily found from the OCC curves easily.

Calculations:

$y = mx$ $\quad Y = OD$

$M = Y/x$ $\quad x = OC$

M = Slope = R_c

$N_s = 1500$ $\quad BC = 20$ $\quad AC = 40$

Critical speed $(N_c) = N_s \times \left(\frac{BC}{AC}\right)$

$= 1500 \times \left(\frac{20}{40}\right)$

$N_c = 750 rpm$

$E_g = 40$ $\quad I_F = 0.68 A$

$$M = \frac{y_2 - y_1}{x_2 - x_1}$$

$$M = \frac{220 - 40}{0.56 - 0.1}$$

$M = 391.30 \sim = R_c$

Procedure:

1. Connect the Circuit as per the Circuit diagram.

2. Keep armature rheostat of the motor in maximum position and Field rheostat of the motor in minimum position and also keep Field rheostat of the generator in maximum position.

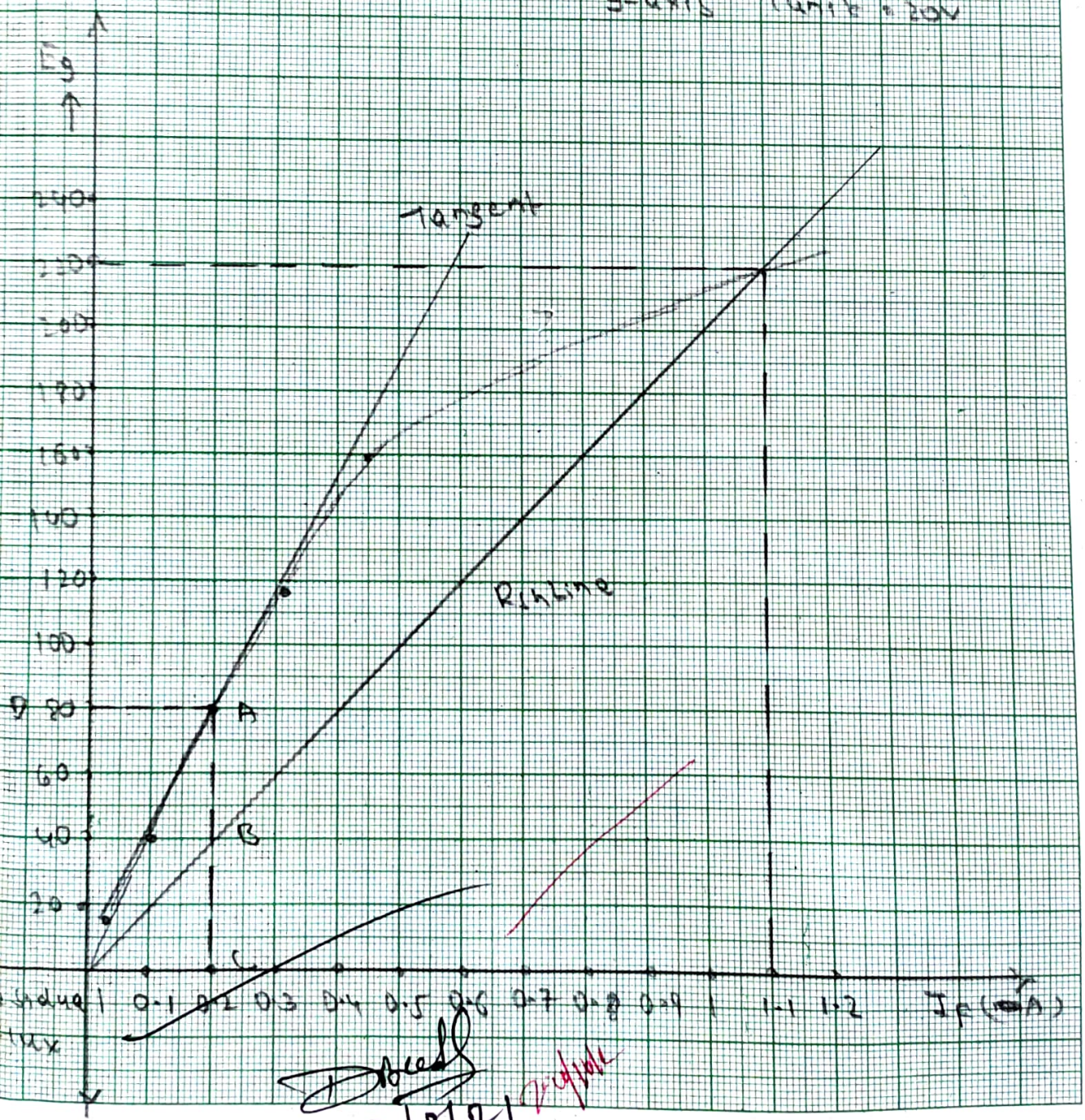
3. Switch ON the DC supply and start the MG set to rated value with the help of armature rheostat of the motor, if rated speed is not reached then adjust the Field rheostat of the motor.

4. Adjust the speed of the MG set to rated value with the help of armature rheostat of the motor, if rated speed is not reached then adjust the Field rheostat of the motor.

5. When MG Set rotates at rated speed a small reading is observed in the voltmeter even though there is no current in the Field winding. In this case Note down the readings of Voltmeter and Ammeter.

Magnetization Characteristics of DC shunt Generator

Scale:
X-axis Unit = 0.1 A
Y-axis Unit = 20V



Good

10 | 8 | 2

6. Now vary the Field rheostat of the Generator in steps to rated voltage and at each step note down the readings of Voltmeter and Ammeter.

7. Switch OFF the DC supply of MG set by making all devices to initial position.

Precautions:

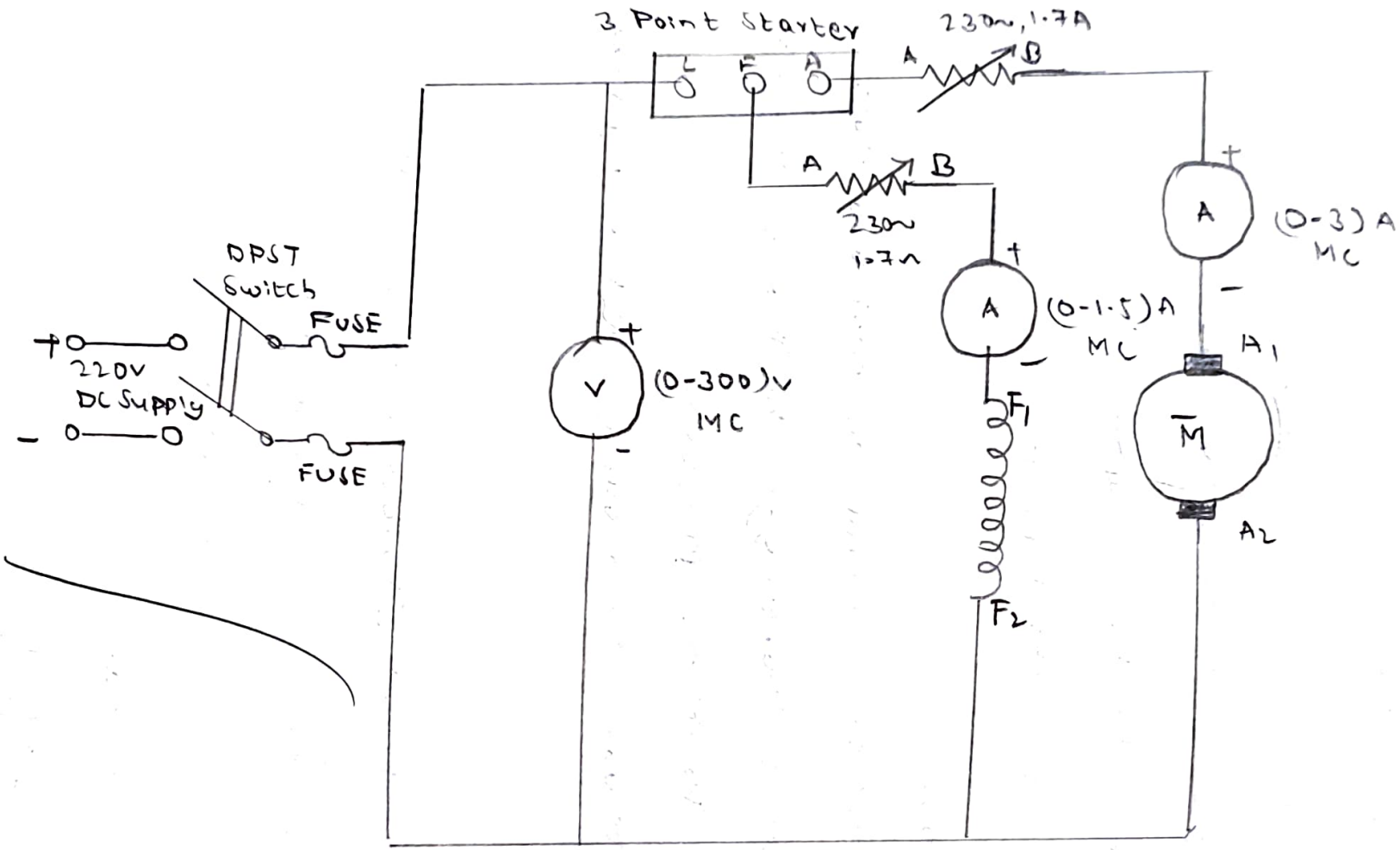
1. Connections should be neat and tight.
2. Before starting of the MG set check the rheostats positions properly.
3. Note down the readings without any parallax error.

Result:

Open Circuit Characteristics of DC shunt generator has been verified and Critical Field resistance and Critical speed has been verified and determined.

10/8/2024

Circuit Diagram:



Title : SWINBURNE'S TEST ON DC SHUNT MACHINE

Date : 3/8/21
Page No. : 6

Aim:

To perform Swinburne's test on DC Shunt motor and predetermine the efficiency of a DC Shunt machine when it is working as a motor and as a generator.

Apparatus Required:

1.	Voltmeter	(0-300) V	MC IND
2.	Ammeter	(0-3) A	MC IND
		(0-1.5) A	MC IND
3.	Rheostat	230Ω, 1.7A	IND
		100Ω, 5A	IND
4.	Tachometer	Analog / Digital	IND

Name Plate Details:

DC Shunt Motor:

K.W : 3.5

Voltage : 220V

Load Current : 18.6A

Speed : 1500rpm

Excitation Current : 0.9A

Excitation Voltage : 220V

Tabular Column:

Motor:

S.NO	I_L (Amps)	V (Volts)	I_{sh} (Amps)	I_a (Amps)	$I_a^2R_a$ (Watts)	Total Losses (watts)	Input (watts)	Output (watts)	η (%)
1	18.6	220	0.6	18	317.52	790.33	4092	3301.67	80.6
2	9.3	220	0.6	8.7	74.17	546.99	2046	1499.01	73.26
3	13.95	220	0.6	13.35	174.65	651.42	3069	2421.52	78.9
4	4.65	220	0.6	4.05	16.07	488.88	1023	534.2	50.6

No load Readings

$V = 110 \times 2 = 220V$

$I_{aO} = 0.78 \times 2 = 1.56\ A$

$I_{sh} = 0.6 \times 1 = 0.6\ A$

$I_{LO} = 2.16\ A$

Armature resistance

$R_a = 0.98$

Title :

Date : 5/8/24
Page No. : 7

Theory :

Swinburne's Test is a simple method in which losses are measured separately and from their knowledge, efficiency at any desired load can be predetermined in advance. However, this test is applicable to those machines in which flux is practically constant i.e shunt and compound wound machines. The machine is run as a motor on noload its rated voltage and rated speed. The speed is adjusted with the help of shunt regulator and note down the readings of no load armature and shunt field current.

The load line current $I_L = I_a - I_{sh}$ Generator

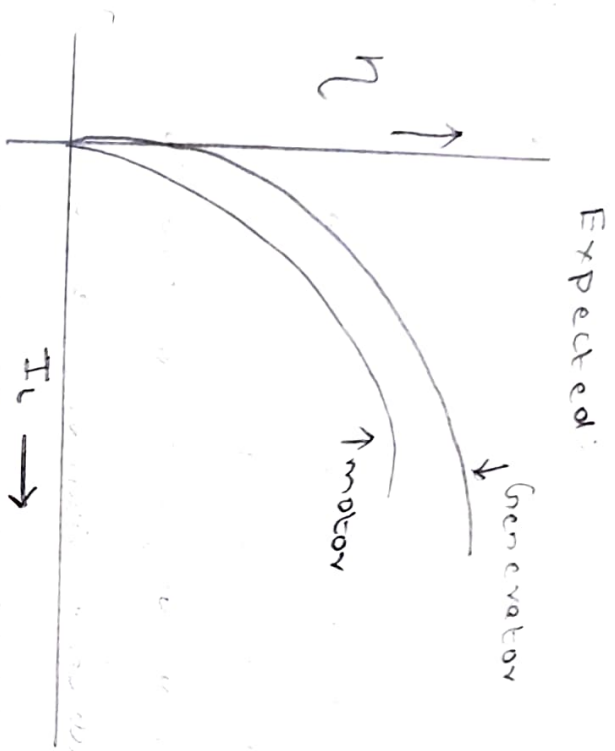
$I_L = I_a + I_{sh}$ Motor.

This test is convenient and economical because power required to test a large machine small ie only no load input power. In this test since constant losses are known. The efficiency of the DC machine can be predetermined at any load.

Tabular Column:

Generator:

S.NO	I_L (Amps)	V (volts)	I_{sh} (Amps)	I_a (Amps)	$I_a^2R_a$ (watts)	Total Losses (watts)	Input (watts)	Output (watts)	η (%)
1.	18.6	220	0.6	19.2	361.26	834.07	4992.1	4092	83.06
2.	9.3	220	0.60	9.9	96.04	568.25	673.9	2046	78.24
3.	13.95	220	0.6	14.5	361.26	678.95	779.5	3069	81.9
4.	4.65	220	0.6	5.25	27.01	499.82	607.11	1023	67.17



Procedure:

1. Connect the circuit as per the circuit diagram as shown in Fig 1.

2. Keep armature rheostat in maximum position and Field rheostat at minimum position.

3. Switch ON the DC supply and start the motor with the help of 3-point starter.

4. Adjust the speed of the Motor to rated value with the help of armature rheostat, if rated speed is not reached then adjust the Field rheostat.

5. Note down the noload readings of voltmeter and ammeter.

6 Switch OFF the DC supply by making all devices to initial position.

Procedure For Finding Armature Resistance (R_a):

1. Connect the circuit as per the circuit diagram as shown in Fig 2.

2. ~~Do~~ Switch ON the DC supply and vary the voltage across armature in steps but should not

Calculations:

No-load I/P = VI_{L0}

$I_{L0} = I_{a0} + I_{sh}$

$I_{L0} = 1.56 + 0.6 = 2.16$

No load armature

Cu loss = $I_{a0}^2 R_a = (1.56)^2 \times 0.98$

$= 2.38$

Constant losses (W_c) =

$VI_{L0} - I_{a0}^2 R_a = 475.2 - 2.38$

$W_c = 472.82W$

As a motor:

Full load:

Load I/P = $VI_L x$

$x \rightarrow$ load factor

$1 \times 220 \times 18.6 = 4092W$

Armature Cu losses = $I_{a0}^2 R_a$

$= (18)^2 \times 0.98 = 317.52W$

$I_a = xI_L - I_{sh} = 18.6 - 0.6 = 18A$

Total losses = $W_c + I_a^2 R_a$ (↳ W_{Cu})

$= 472.82 + 317.52 = 790.34$

$\eta_m = \frac{I/P - TL}{I/P} = \frac{xVI_L - 790.34}{xVI_L} \times 100$

$\eta_m = 80.6\%$

Output = I/P − Total losses

$= 4092 - 790.34$

$= 3301.66W$

1/2 Load →

Load I/P = $V\frac{I_L}{2} = 2046W$

Armature Cu losses $W_{Cu} = I_a^2 R_a$

$I_a = I_L - I_{sh} = 9.3 - 0.6 = 8.7A$

$W_{Cu} = (8.7)^2 (0.98) = 74.17W$

Total losses = $W_c + I_a^2 R_a$

$= 74.17 + 472.82 = 546.99$

Input = xVI_L $x \rightarrow 1/2$

$= \frac{1/2 \times 220 \times 18.6 - 546.99}{2046} \times 100$

$= 73.26\%$

O/P = I/P − Total losses

$= 2046 - 546.99$

O/P = 1499.61W

Armature Cu loss $W_{Cu} = I_a^2 R_a$

$I_a = I_L - I_{sh}$

$= 465 - 0.6 = 4.05$

$W_{Cu} = (4.05)^2 (0.98) = 16.07W$

Total losses = $W_c + I_a^2 R_a$

$= 16.07 + 472.82 = 488.89$

$x \rightarrow 1/4$ Input = xVI_L

$= \frac{1/4 \times 220 \times 18.6 - 488.89}{1/4 220 \times 18.6} \times 100$

$= 50.6\%$

O/P = 1023 − 488.89

O/P = 534.2W

exceed rated voltage.

[3. Switch ON the DC supply and]

3. At each step note down the readings of voltmeter and Ammeter.

4. Now calculate the armature Resistance (R_a) by using given Formula $R_a = \frac{V}{I_a}$

5. Exact armature resistance (R_a) value is Obtained by taking mean of the readings.

Precautions:

1. Connections should be neat and tight.

2. Before starting of the motor ensure that there is no load on the motor. and also check rheostat position properly.

3. Note down the readings without any parallax error.

Generator:

$I_a = I_L + I_{sh}$

$I_a = 18.6 + 1 = 19.6\ A$

Full load:

Load output $= \times V I_L = 4092\ W$

$W_{cu} = I_a^2 R_a = 345.744\ W$

$I_a = \times I_L + I_{sh} = 1 \times 18.6 + 1$
$= 19.6\ A$

Total Losses $= W_{cu} + W_c$
$= 924.12\ W$

$$\eta_{Full} = \frac{O/P}{O/P + T_L} \times 100$$

$$= \frac{4092}{4092 + 924.12} \times 100$$

$$\boxed{\eta_{Full} = 81.57\%}$$

½ Load →

Load output $= \frac{V I_L}{2} = 2046\ W$

$W_{cu} = I_a^2 R_a = 95.481\ W$

$I_a = \frac{I_L}{2} + I_{sh} = 10.3\ A$

Total losses $= W_c + W_{cu}$
$= 673.861$

$$\eta_{1/2} = \frac{2046}{2046 + 673.861} \times 100$$

$$\boxed{\eta_{1/2} = 75.22\%}$$

¾ Load:

Load Output $= V I_L \times 3/4$
$= 3069\ W$

Armature Cu loss
$W_{cu} = I_a^2 R_a$

$I_a = I_L \times \frac{3}{4} + I_{sh} = 14.95\ A$

$W_{cu} = (14.95)^2 \times 0.9 = 201.152\ W$

Total losses $= W_c + W_{cu}$
$= 779.532\ W$

$$\eta_{3/4} = \frac{3069}{3069 + 779.532}$$

$$\boxed{\eta_{3/4} = 79.74\%}$$

¼ Load →

Load output $= \frac{V I_L}{4} = 1023\ W$

Armature Cu loss $W_{cu} = I_a^2 R_a$

$I_a = \frac{I_L}{4} + I_{sh} = 5.65\ A$

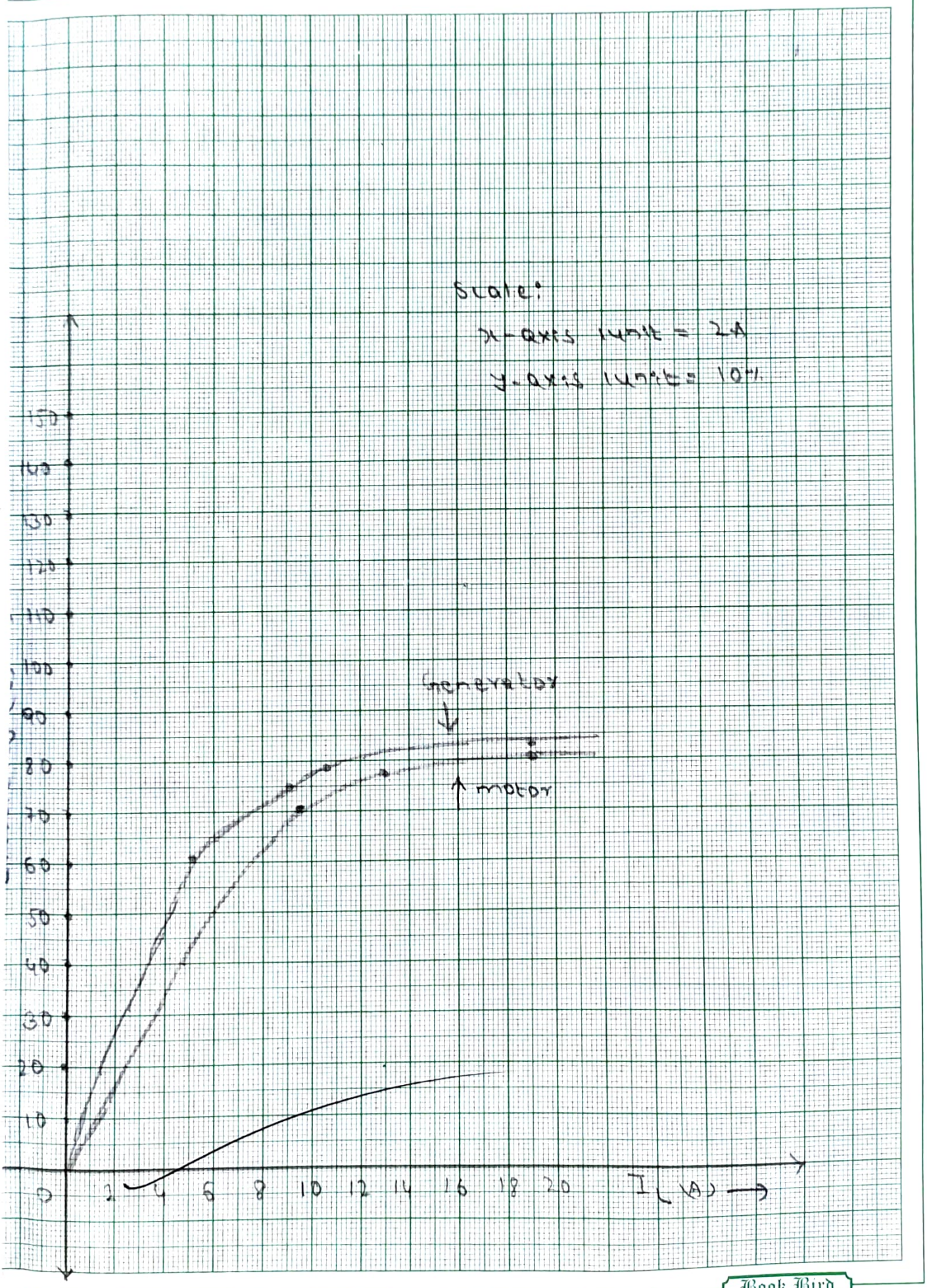
$W_{cu} = (5.65)^2 (0.9) = 28.73\ W$

Total losses $= W_c + W_{cu}$
$= 609.11\ W$

$$\eta_{1/4} = \frac{1023}{1023 + 609.11} \times 100$$

$$\boxed{\eta_{1/4} = 62.75\%}$$

Swinburne's Test on DC Shunt machine



Title :

Date : 31/8/24
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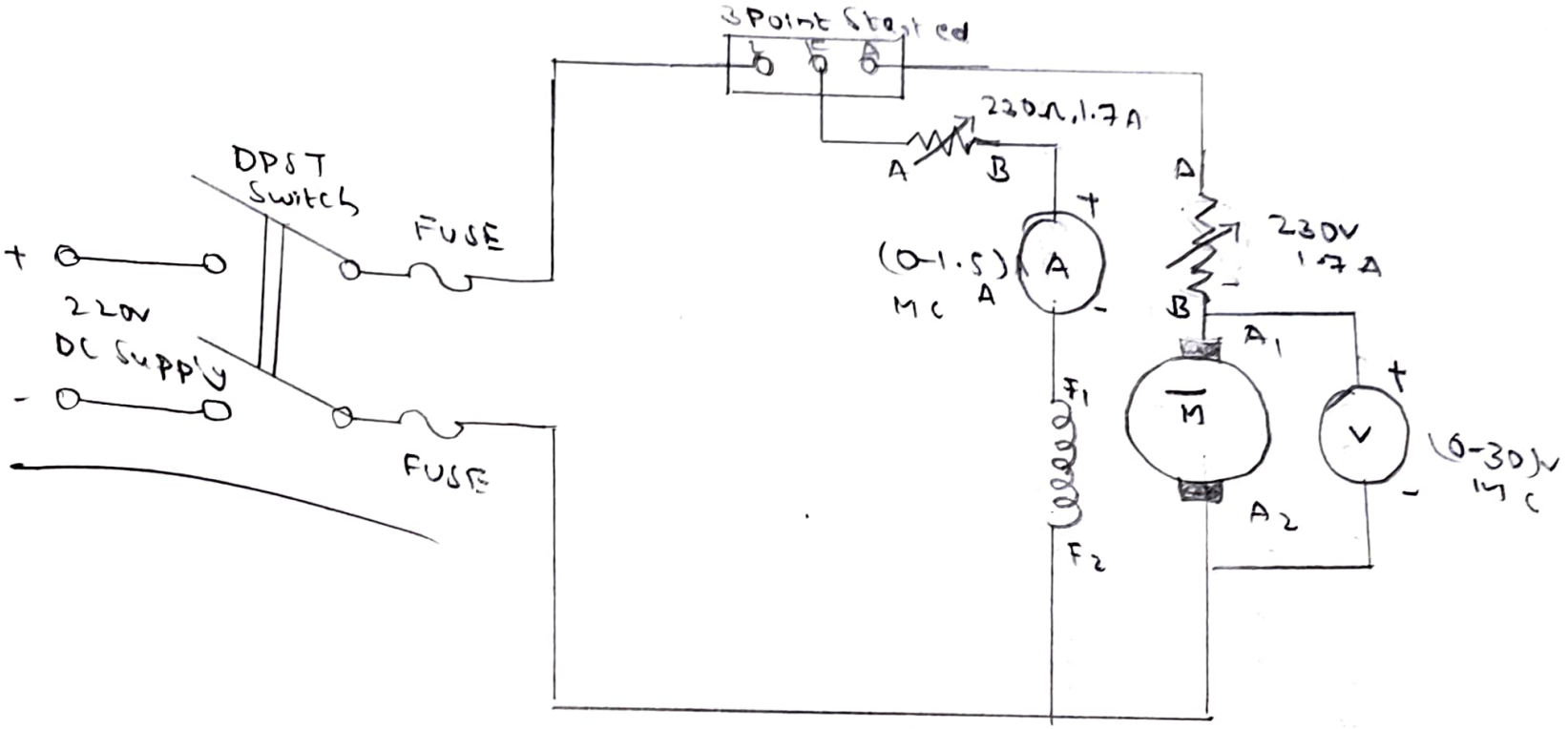
Result:

The experiment of the given DC machine was done and determined the efficiency at Full, 3/4, 1/2, 1/4 Loads when machine is working as generator as well as motor and neccessary graph were drawn.

13/08/2024

Circuit Diagram



Title : Speed Control of DC Shunt Motor; Date : 5/8/24
Page No. : 11

Aim:

To study the variation of speed of a DC shunt motor by varying voltage across the armature and shunt field current

Apparatus Required:

1.	Voltmeter	(0-300)V	MC	1NO
2.	Ammeter	(0-1.5)V	MC	1NO
3.	Rheostat	230Ω, 1.7A		2NO's
4.	Tachometer	Analog/Digital		1

Name Plate Details:

DC Shunt Motor:

K.W: 3.5

Voltage: 220V

Current: 18.6A

Speed: 1500 rpm

Excitation Current: 0.6A

Excitation Voltage: 220V

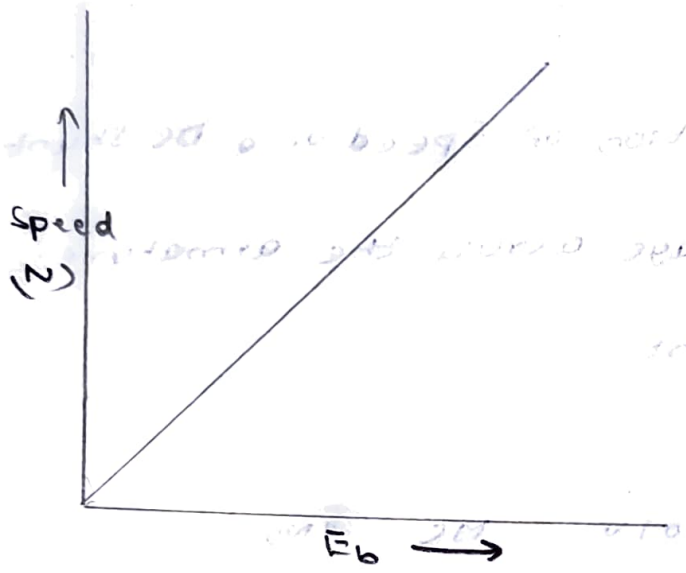
Fuse rating Calculations:

For Noload → 20% (FL Current)

For Fullload = 125%

$\frac{20}{100} \times 18.6 = 3.72A$ $\frac{125}{100} \times 18.6 = 23.25A$

Expected graphs:



Theory:

Armature Control Method:

This method is also termed as Rheostatic Control method. In this method resistance of armature circuit is varied by introducing a variable resistance into the armature circuit.

With the variable Resistance R Fully cut in, it is observed that the speed is minimum. When R is maximum there is maximum drop across it and voltage across the motor armature is minimum Hence Speed is minimum.

Field Control Method:

In this method of Speed Control a Variable resistance is incorporated in the Field Current. With the resistance R Fully cut out the Speed is minimum Since Field Current is maximum and maximum Flux is produced.

Tabular Column:

Armature Control Method I_F = 0.48 Constant

S.NO	E_b (Volts)	Speed (N) rpm
1	110×2	1500
2	104×2	1400
3	100×2	1300
4	95×2	1200

Field Control Method:

S.NO	Field Current I_F (Amps)	Speed (N) rpm
1	0.48	1500
2	0.44	1600
3	0.32	1700
4	0.2	1806

Procedure:

1. Connect the circuit as per the circuit diagram.

2. Keep armature rheostat in maximum position and Field rheostat in minimum rheostat position.

3. Switch ON the DC supply and start the Motor with the help of 3point starter.

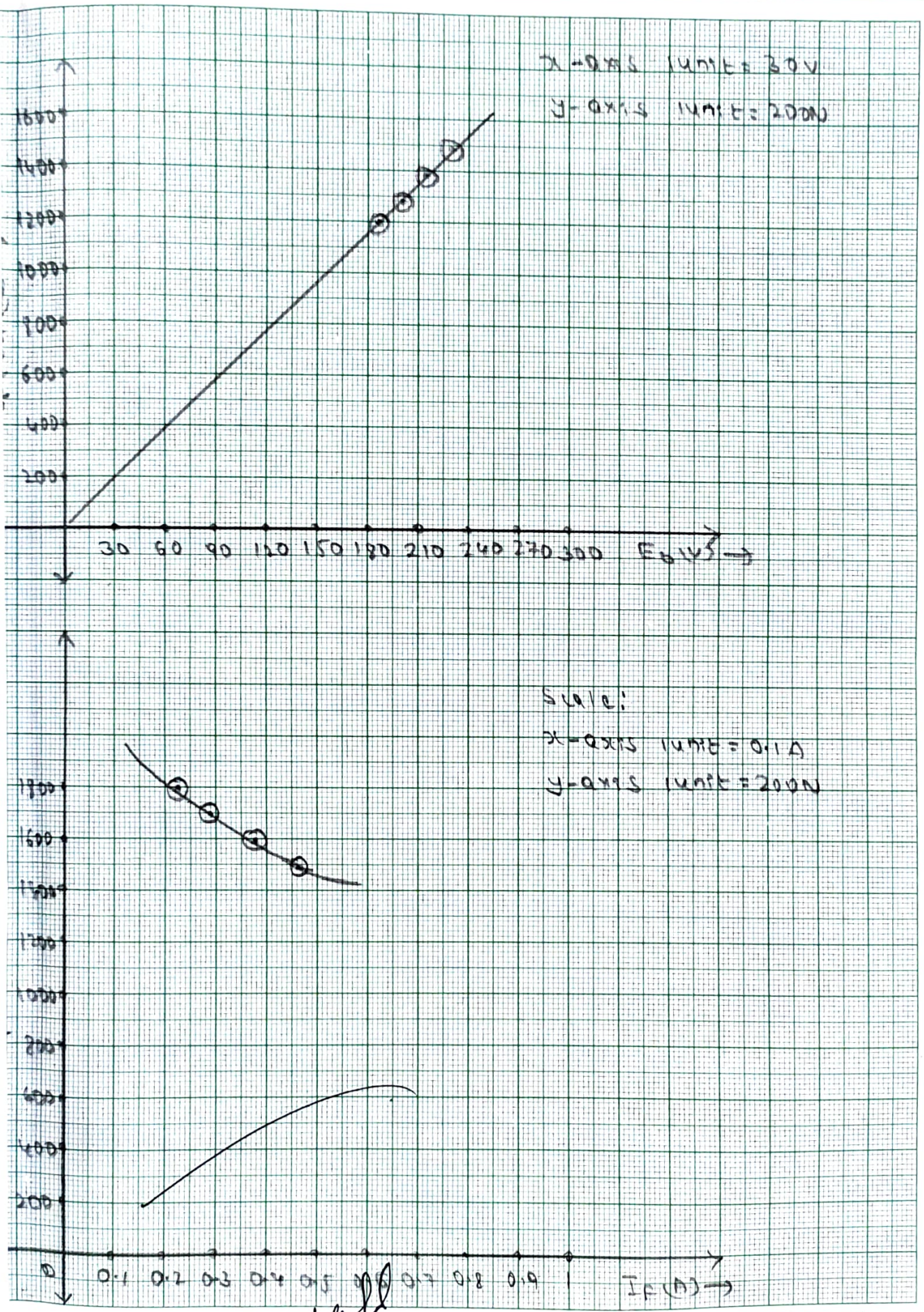
4. Adjust the Speed of the motor to rated value with the help of armature rheostat, if rated speed is not reached then adjust the Field rheostat.

Armature Control Method:

1. In this method keep Shunt Field Current Constant and vary the voltage across armature in steps to 1200rpm with the help of armature rheostat.

2. At each step note down the readings of Speed and voltage across armature (E_b).

Speed Control of DC shunt motor



Book Bird

Title :

Date : 5/8/21
Page No. : 14

Field Control Method:

1. In Field Control Method bring the motor speed to rated value and keep the voltage across armature constant

2. Now vary the Shunt Field Current in steps to 1800 rpm with the help of Field rheostat and at each step note down the readings of Speed and Shunt Field Current.

3. Switch OFF the DC supply by making all devices to initial position.

Precautions:

1. Connections should be neat and tight.

2. Note down the readings without any Parallax error.

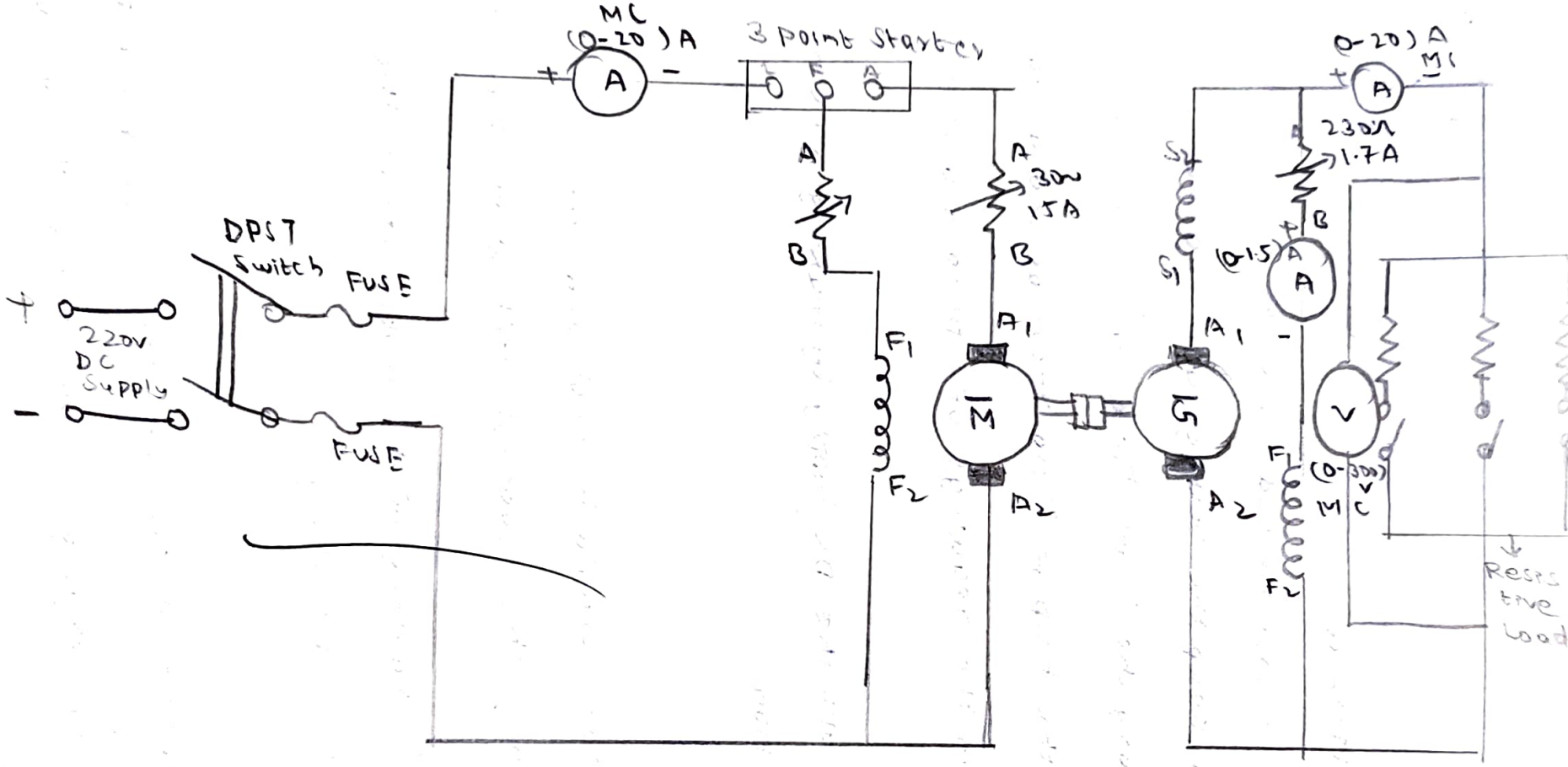
3. Before starting of the motor check the rheostat position properly.

Result:

The experiment on Variation of Speed of a DC Shunt motor by varying voltage across the armature and Shunt Field Current was done and graph were drawn.

(A) Reddy
5/8/2021

Circuit Diagram



Title : Load Test on DC Compound Generator

Date : 5/8/14

Aim:

To perform load test on Compound Generator and to determine its Load Characteristics.

Apparatus Required:

1. Voltmeter	(0-300)V	MC	2 No's
2. Ammeter	(0-20)A	MC	2 NO's
	(0-1.5)A	MC	1 NO
3. Resistive Load 5KW, 20A			1 NO
4. Rheostat	230Ω, 1.7A		2 No's
	30Ω, 25A		1 No
5. Tachometer	Analog/Digital		1 No

Name Plate Details:

DC Shunt Motor

K.W: 5.2

Voltage: 220

Current: 27.5

Speed: 1500 rpm

Shunt Field Current: 0.85A

DC Shunt Generator:

K.W: 3.7

Voltage: 220V

Load Current: 16.5A

Speed: 1500 rpm

Shunt Field Current: 0.6A

Tabular Column:

S.NO	Vm (V)	Im (Amps)	Vg (V)	Ifg (Amps)	Ishg (Amps)	Iag (Amps)	Iag(Ra + Rse) volts	Eg (volts)	Input (watts)	Output (watts)	η %
1	102×2	5×2	220	0	0.6	0.6	1.59	221.5	1080	0	0
2	107×2	6.8×2	220	11.6	0.6	2.2	5.83	225.8	1445.2	352	24.4%
3	106×2	9×2	210	3.8	0.6	4.4	11.64	221.6	1908	798	41.52%
4	105×2	12×2	202	7	0.56	7.56	20.03	222	2520	1414	56.11%
5	104×2	19×2	176	14.4	0.48	14.8	39.4	215.4	3952	2534.4	64.12%

Title :

Date : 5/8/24
Page No. : 16

Theory:

The efficiencies of all DC machines can be computed in two days. 1. Direct Test

2. Indirect Test.

In Direct Method the Input and Output power can be measured by suitable means and efficiency computed as a ratio of Output to Input.

A direct method is not used for large machines as:

a) It may not be possible to provide the necessary load.

b) Even if load is arranged there would be enormous power loss during the test.

It is used to determine the load characteristics of the generator and also change in efficiency when the load on the generator varies.

The load characteristics are drawn between

1. Generated voltage (V_g) and load current (I_{lg}).

2. Efficiency and load current (I_{lg})

Procedure:

1. Connect the Circuit as per the Circuit diagram.

2. Keep Field rheostat of the motor in minimum position and armature rheostat of the Motor in maximum position.

3. Switch ON the DC Supply and Start the MG Set with the help of 3point Starter.

4. Adjust the MG Set Speed to rated value with the help of armature rheostat of the motor. If rated Speed is not reached then adjust the Field rheostat of the motor.

5. Now, adjust the Field rheostat of the generator to rated voltage of the generator.

6. Note down the No-load readings of Voltmeter and Ammeters.

7. Now vary the load in steps to rated Current of the generator and at each step note down the readings of Voltmeter and Ammeter and also at

Calculations:

① $I_{ag} = 0 + 0.6 = 0.6\,A$

$E_g = V_g + I_{ag}(R_a + R_{se})$

$= 220 + 0.6(2.22 + 0.43)$

$E_g = 221.59\,V$

$I/P = V_m I_m = 216 \times 5$

$= 1080\,W$

$O/P = V_g \times I_{Lg} = 220 \times 0 = 0$

$\eta = \frac{0}{1080} \times 100 = 0$

② $I_{ag} = 0.8 * 2 + 0.6 = 2.2A$

$E_g = 220 + 2.2(2.22 + 0.43)$

$E_g = 225.8\,V$

$I/P = 107 \times 2 \times 3.4 \times 2 = 1455\,W$

$O/P = 110 \times 2 \times 0.8 \times 2 = 352\,W$

$\eta = \frac{352}{1455.2} \times 100 = 24.18\%$

③ $I_{ag} = 1.9 \times 2 + 0.6 = 4.4\,A$

$E_g = 210 + 4.4(2.22 + 0.43)$

$E_g = 221.66\,V$

$I/P = V_m I_m = 106 \times 2 \times 4.5 \times 2$

$= 1908\,W$

$O/P = V_g I_{Lg} = 210 \times 1.9 \times 2$

$= 798\,W$

$\eta = \frac{798}{1908} \times 100 = 41.82\%$

④ $I_{ag} = 2.5 \times 2 + 0.56 = 7.56\,A$

$E_g = 202 + 7.56(2.22 + 0.43)$

$E_g = 222.086$

$I/P = 105 \times 2 \times 3.5 \times 2 = 2520$

$O/P = 2102 \times 3.5 \times 2 = 1414$

$\eta = \frac{1414}{2520} \times 100 = 56.11\%$

⑤ $I_{ag} = 4.9 \times 2 + 0.53 = 10.33$

$E_g = 96 \times 2 + 10.33(2.22 + 0$

$E_g = 219.3\,V$

$I/P = 210 \times 7.4 \times 2 = 3108$

$O/P = 96 \times 2 \times 4.9 \times 2 = 1831$

$\eta = \frac{1831.6}{3108} \times 100 = 60.54$

⑥ $I_{ag} = 7.2 \times 2 + 0.48 = 14.88\,A$

$E_g = 88 \times 2 + 14.88(2.22 + 0.$

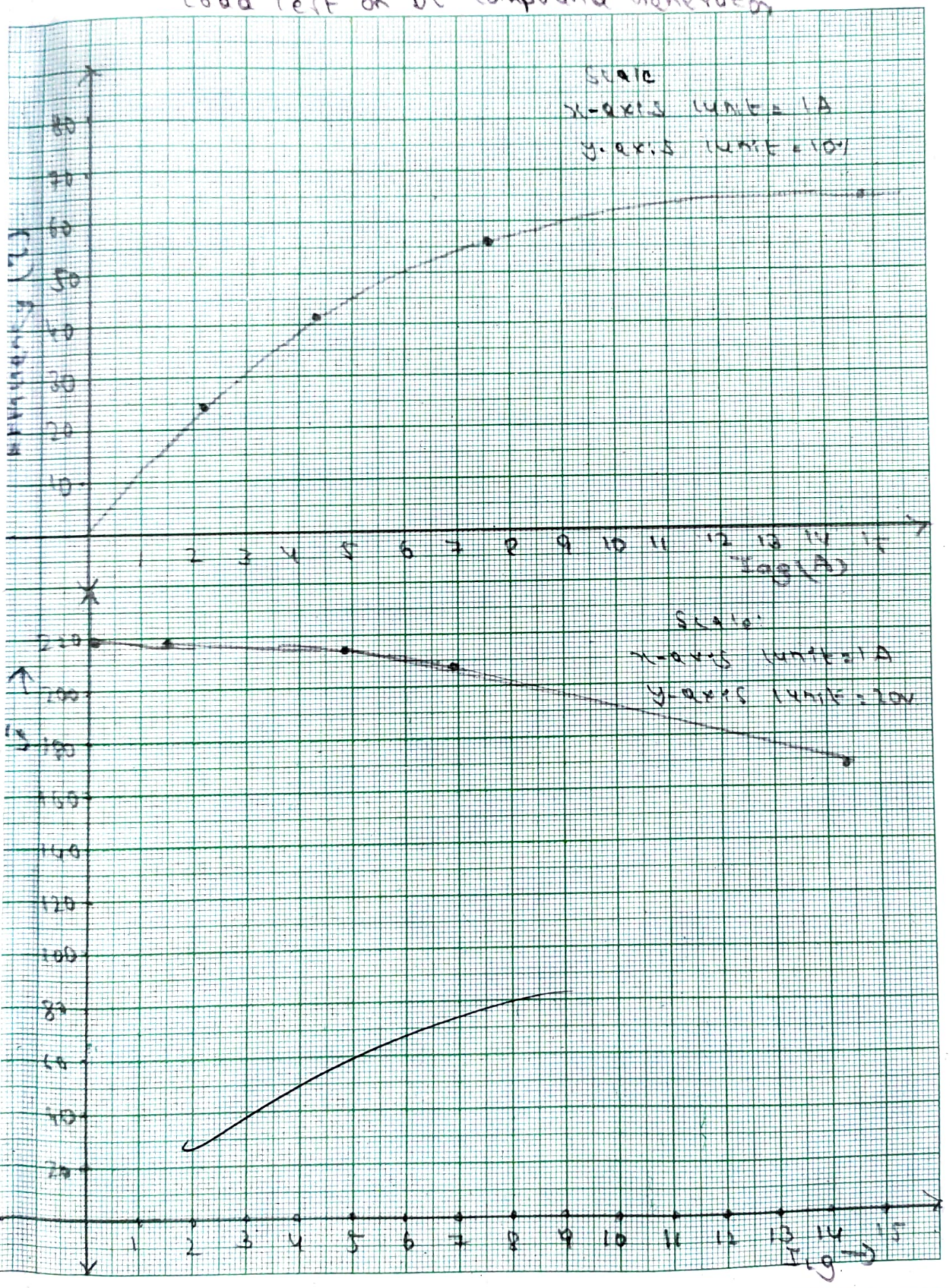
$E_g = 215.43\,V$

$I/P = 104 \times 2 \times 9.8 \times 2 = 3952\,W$

$O/P = 88 \times 2 \times 7.2 \times 2 = 2534$

$\eta = \frac{2534.4}{3952} \times 100 = 64.12\%$

Load Test on DC Compound Generator



each step maintain constant speed with the help of Field rheostat of the motor.

8. Switch OFF the load to zero position and also switch OFF DC supply by making all devices to initial position.

Precautions:

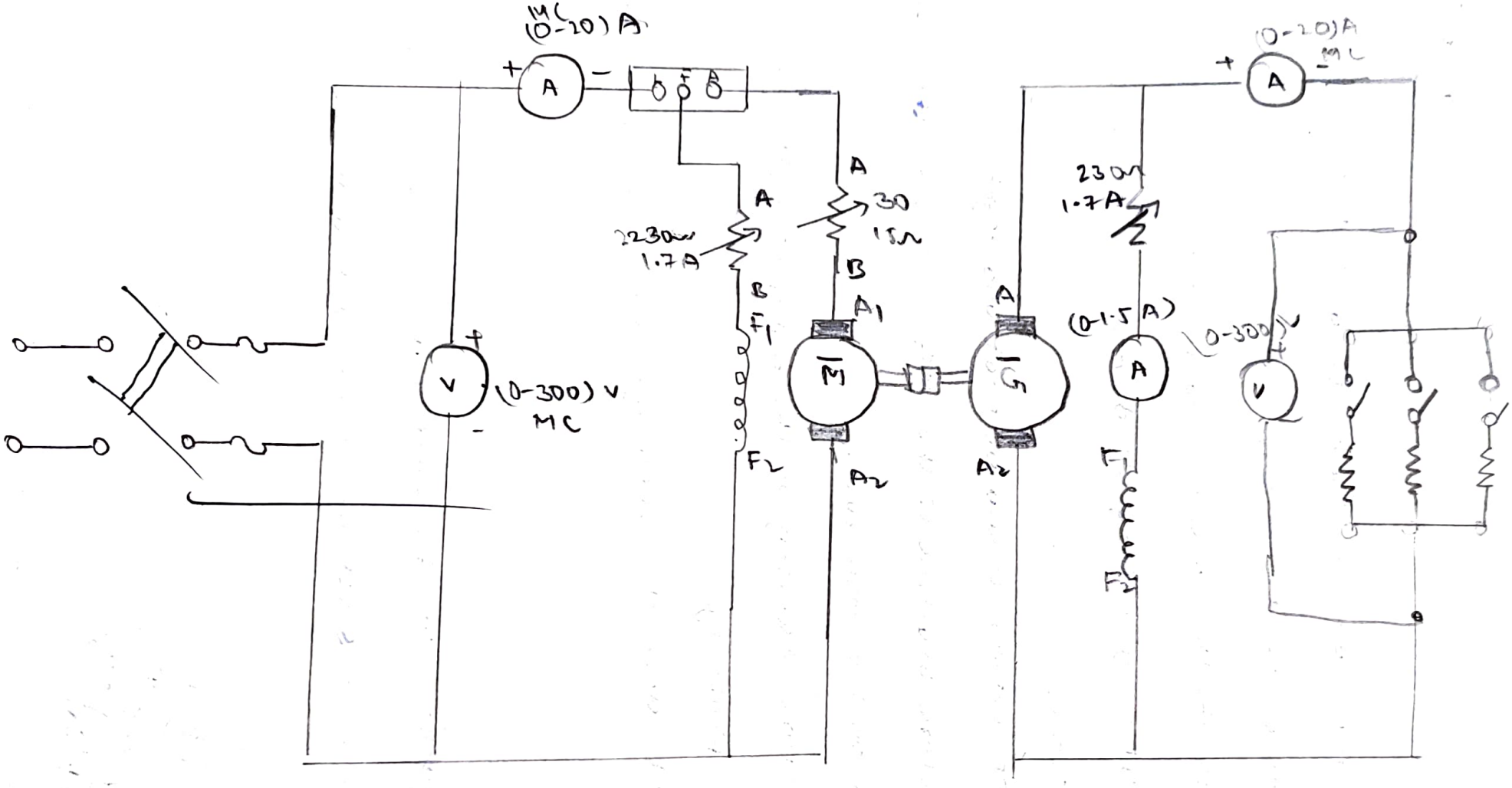
1. Connections should be neat and tight.
2. Before starting of the MG set ensure that there is no load on the Generator.
3. Before starting of the motor check the rheostat positions properly.
4. Note down the readings without any parallax error.

Result:

Load test on DC Compound Generator and its load characteristics are verified and determined.

18/09/2024

Circuit Diagram:



Title: Load Test on DC Shunt Generator: Date: 5/8/21 Page No.: 19

Aim:

To Conduct load Test on DC Shunt Generator and draw its external and Internal Characteristics.

Apparatus Required:

1.	Voltmeter	(0-300) V	MC	1
2.	Ammeter	(0-20) A	MC	1
		(0-25) A	MC	1
3.	Rheostats	370Ω, 1.7A		2
		30Ω, 2.5A		1
4.	Tachometer	Analog / Digital		1
5.	Connecting wires			as per required.

Name Plate Details:

Motor:

K.W: 5 KW

Voltage: 220V

Current: 20A

Excitation Current: 0.9A

Excitation Voltage: 220V

Generator:

K.W: 3.7 KW

Voltage: 220V

Current: 20A

Excitation Current: 0.92A

Excitation Voltage: 220V

Fuse rating Calculation:

Full Load $\frac{125}{100} \times 20 = 25A$

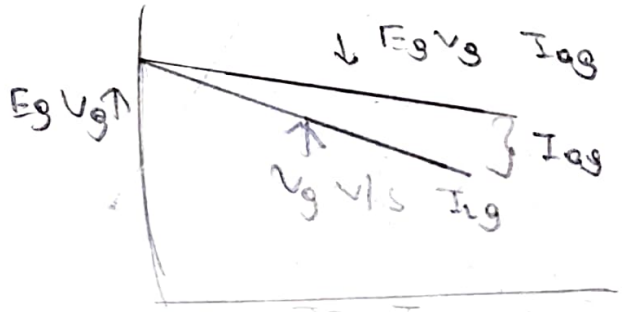
No Load = $\frac{20}{100} \times 20 = 4A$

Tabular Column:

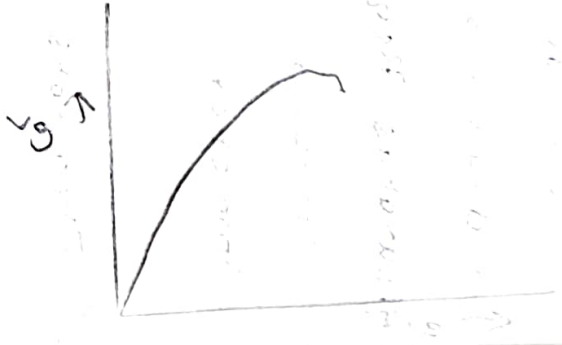
S.NO	Vm (V)	Ilm (Amps)	Vg (V)	Ilg (Amps)	Isg (Amps)	Iag (Amps)	IagRa (volts)	Eg (volts)	Input (watts)	Output (watts)	Efficiency η(%)
1	106x2	1.2x2	220	0	0.6	0.6	0.585	220.18	808.8	0	0
2	106x2	1.4x2	216	0.6x2	0.6	1.8	1.764	217.76	720.8	259.2	35.06%
3	107x2	2.2x2	214	1x2	0.6	2	2.548	210.54	941.6	420	45.48%
4	107x2	3.2x2	208	2x2	0.6	4.6	4.508	212.9	1369.6	932	60.74%
5	107x2	6.2x2	198	3.2x2	0.53	7.63	7.87	205.87	2011.6	1381	68.94%
6	107x2	7x2	174	6x2	0.4	12.46	12.21	299.6	2996	2088	69.69%

Expected Graph:

Internal Characteristics



External Characteristics



Theory :

The efficiencies of all DC machines can be computed in two ways;

1. Direct Test 2. Indirect Test.

Internal and External Characteristics:

If a shunt generator is loaded its terminal voltage decreases due to armature resistance and armature reaction. As the machine supplies more and more load current, there is increased I_aR_a drop and greater demagnetizing effect. The combined effect is that the terminal voltage progressively decreases and diminishes with increase of load current, Hence the graph of V v/s I_L i.e external characteristics is a drooping curve.

For a loaded shunt Generator

$$I_a = I_L + I_{sh}$$

$$E = V + I_aR_a.$$

Calculations:

1)

$V_m = 106 \times 2 = 212V$

$V_g = 220V$

$I_{Lm} = 1.2 \times 2 = 2.4A$

$I_{Lg} = 0A$

$I_{ag} = I_{Lg} + I_{sh}$

$I_{ag} = 0 + 0.6 = 0.6A$

$R_a = 0.9\Omega$

$E_g = V_g + I_{ag} R_a$

$= 220 + 0.6(0.9\Omega)$

$E_g = 220.56V$

$I/P = V_m \times I_{Lg} = 212 \times 2.4$

$I/P = 509.8W$

$O/P = V_g I_{Lg} = 0W$

$\eta = O/P / I/P \times 100$

$\eta = \frac{0}{509.8} \times 100$

$\boxed{\eta = 0}$

2) $V_m = 106 \times 2 = 212V$

$I_{Lm} = 1.7 \times 2 = 3.4A$

$I_{ag} = I_{Lg} + I_{sh}$

$= (0.6 \times 2) + 0.6$

$I_{ag} = 1.8A \quad R_a = 0.9\Omega$

$V_g = 108 \times 2 = 216V$

$I_{Lg} = 0.6 \times 2 = 1.2A$

$E_g = V_g + I_{ag} R_a$

$= 216 + 1.8 \times 0.9\Omega$

$E_g = 217.76V$

$I/P = V_m I_{Lm} = 720.8W$

$O/P = V_g I_{Lg} = 259.2W$

$\eta = \frac{259.2}{720.8} \times 100$

$\boxed{\eta = 35\%}$

3) $V_m = 107 \times 2 = 204V$

$I_{Lm} = 2.2 \times 2 = 4.4V$

$I_{ag} = I_{Lg} + I_{sh} = 2 + 0.6 = 2.6A$

$V_g = 107 \times 2 = 214V$

$I_{Lg} = 1 \times 2 = 2A$

$R = 0.9\Omega$

$E_g = V_g + I_{ag} R_a$

$= 107 \times 2 + 2.6(0.9\Omega)$

$E_g = 216.54V$

$I/P = V_m I_{Lm} = 941.6W$

$O/P = V_g I_{Lg} = 438.W$

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

$\eta = \frac{43.8}{941.6} \times 100$

$\boxed{\eta = 46.5\%}$

4) $V_m = 107 \times 2 = 214V$

$I_{Lm} = 3.2 \times 2 = 6.4V$

$V_g = 104 \times 2 = 208V$

$I_{Lg} = 2 \times 2 = 4A$

$I_{ag} = I_{Lg} + I_{sh} = 4 + 0.6$

$= 4.6A$

$E_g = V_g + I_{ag} R_a$

$E_g = 208 + 4.6(0.9\Omega) = 212$

$I/P = V_m I_{Lm} = 1369.6W$

$O/P = V_g I_{Lg} = 832W$

$\eta = \frac{832}{1369.6} \times 100$

$\boxed{\eta = 60.7\%}$

Procedure:

1. Connect the circuit as per the circuit diagram.

2. Keep Field rheostat of the motor in minimum position and armature rheostat of the motor at maximum position and also Generator Field rheostat at maximum position.

3. Supply ON the DC supply and start the MG Set with the help of 3-point starter.

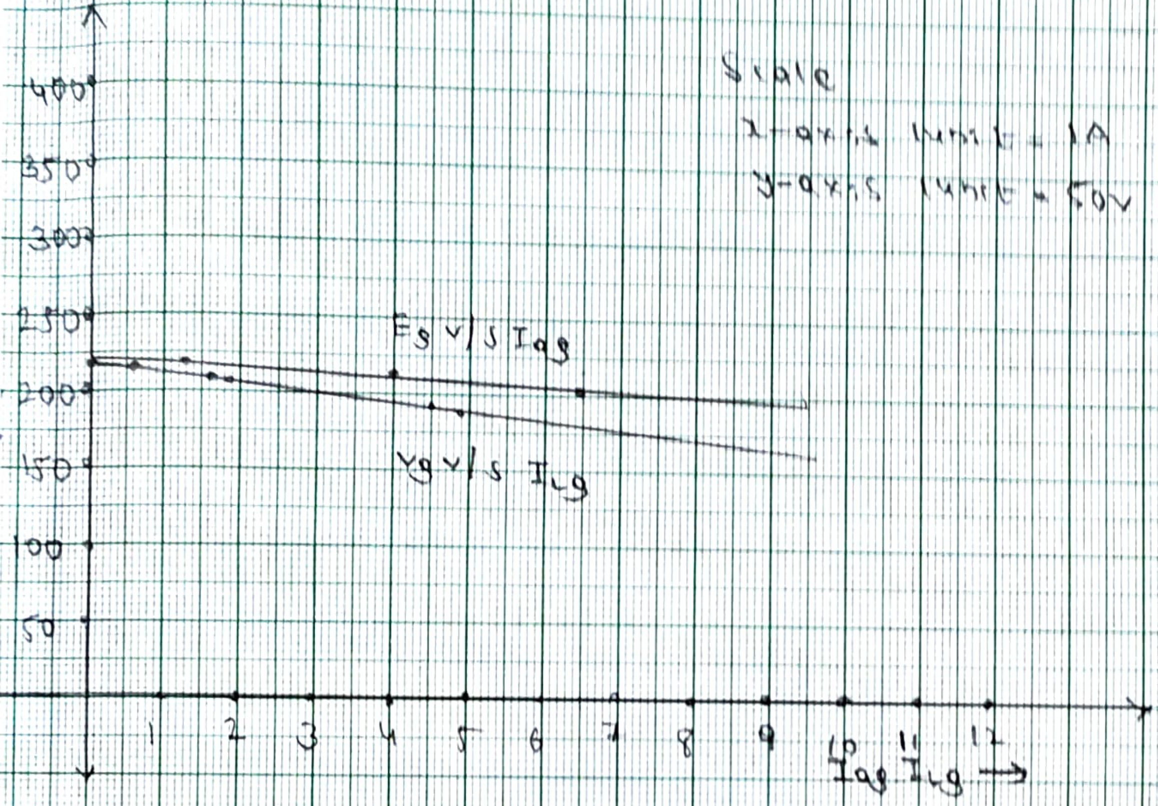
4. Adjust the MG Set speed to rated value with the help of armature rheostat of the motor. If rated speed is not reached then adjust the Field rheostat of the motor.

5. Now, adjust the Field rheostat of the generator to rated voltage of the generator.

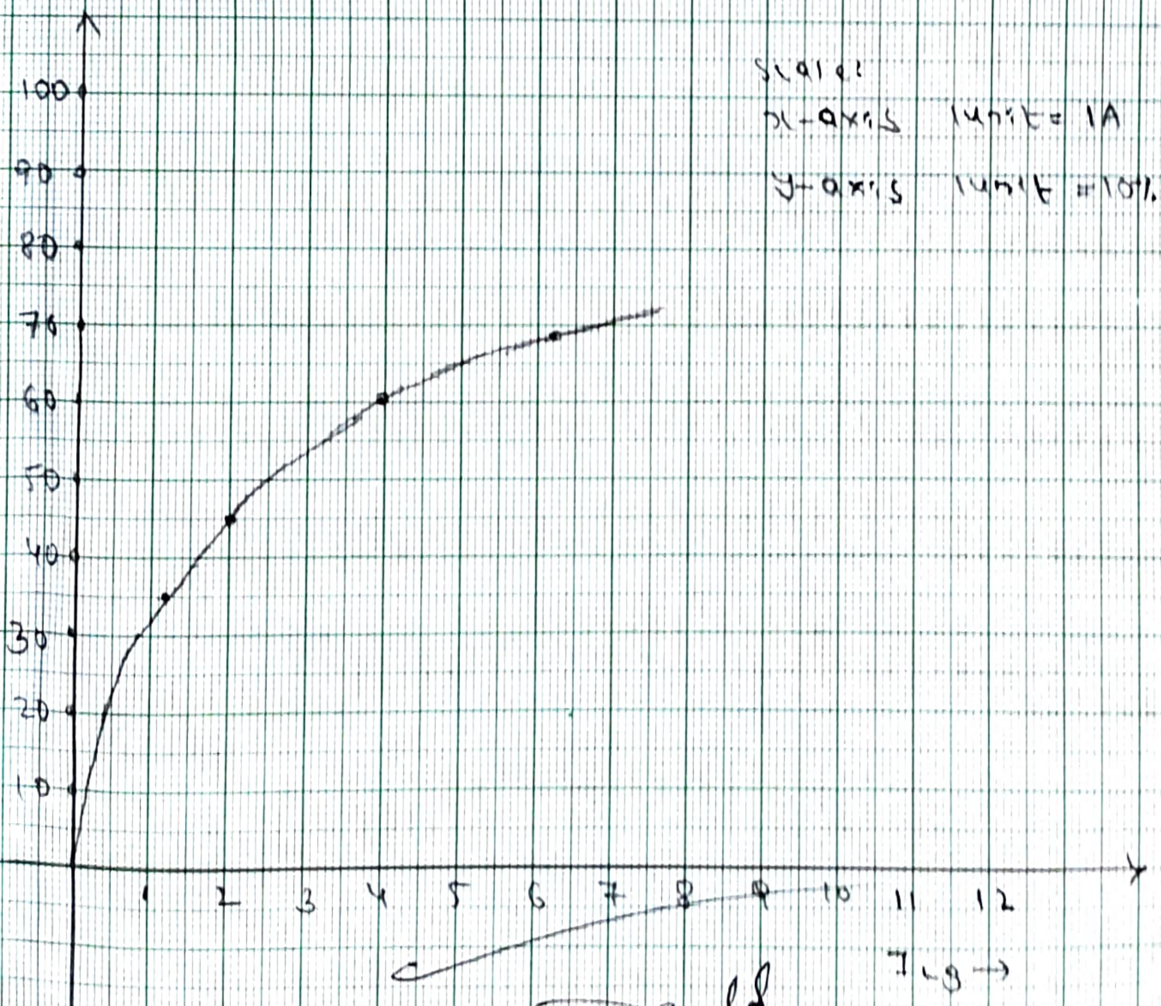
6. Note down the No-load readings of Voltmeter and Ammeter.

7. Now vary the load in steps to rated current

Load Test on DC Shunt Generator



Scale
x-axis 1unit = 1A
y-axis 1unit = 50V



Scale:
x-axis 1unit = 1A
y-axis 1unit = 10%

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of the generator and at each step note down the readings of Voltmeter and Ammeter and also at each step ~~of~~ maintain Constant Speed with the help of Field rheostat of the motor.

8. Switch OFF the load to Zero position and also switch OFF DC Supply by making all devices to initial position.

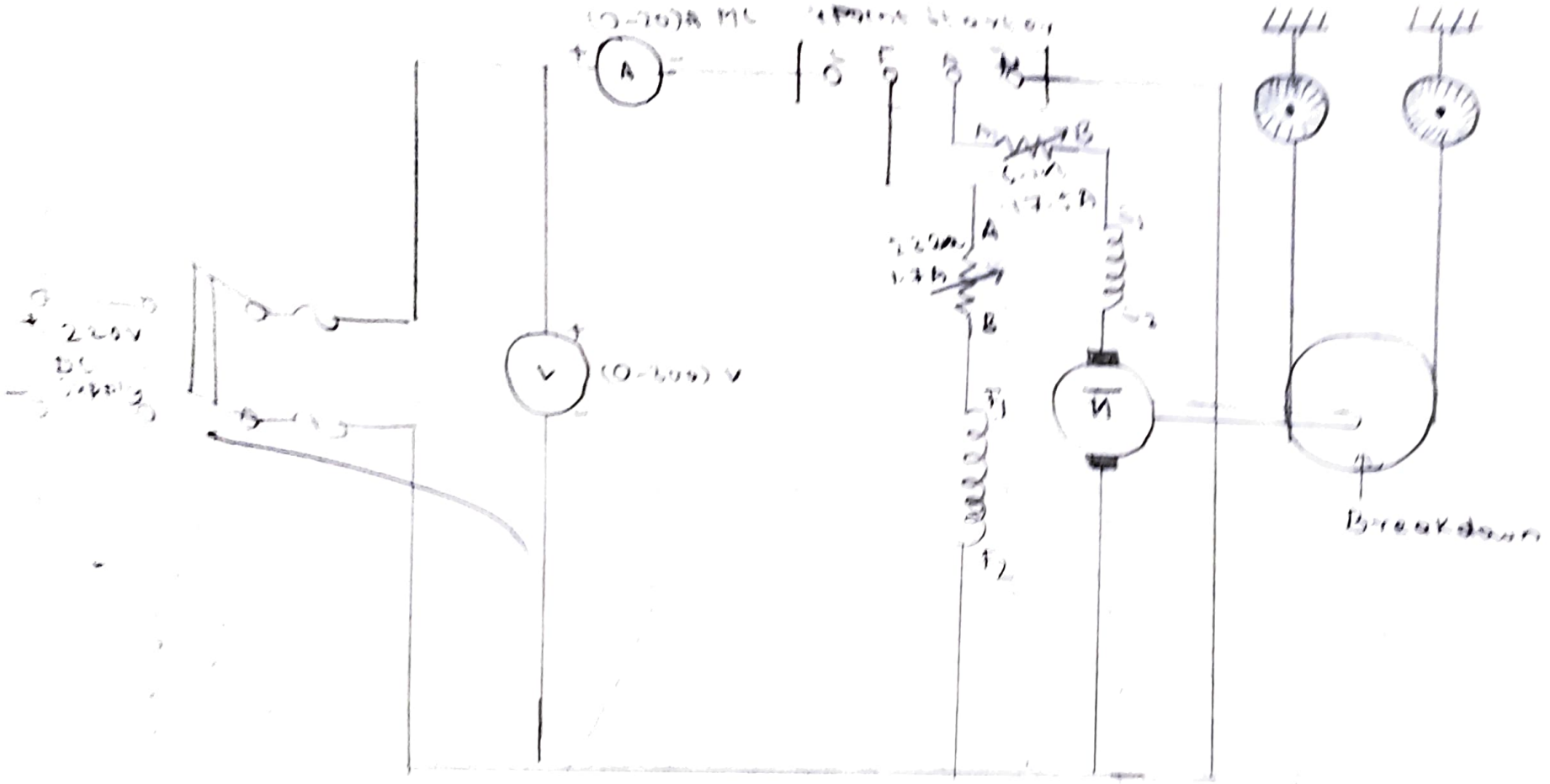
Precautions:

1. Connections Should be neat and tight.
2. Before Starting of the M/G Set ensure that there is no load on the generator.

Result:

Load Test on DC Shunt Generator and its internal and external characteristics are verified and determined.

13/08/2021


A
V
(0-600) V
Breakdown

Title: Brake Test on DC Compound Motor

Date : 5/8/21

Page No.: 23

Aim:

To perform Brake Test on DC Compound Motor and determine its performance Characteristics.

Apparatus Required:

1. Voltmeter	(0-300)V	MC	1No
2. Ammeter	(0-20)A	MC	1No
3. Rheostat	230Ω, 1.7A		1No
	6.1Ω, 17.5A		1No
4. Tachometer	Analog/Digital		1No

Name Plate Details:

DC Compound Motor:

K.W: 3.5

Voltage: 220V

Current: 18.6A

Speed: 1500rpm

Excitation Current: 0.6A

Excitation Voltage: 120V

Tabular Column:

$r = 0.16m$

S.NO	Loads		Current I_L (Amps)	Voltage V (Volts)	Speed N (rpm)	Torque (T) (N-m)	Input (Watts)	Output (Watts)	η (%)
	L_1 (kg)	L_2 (kg)							
1	0	0	1×2	110×2	1500	0	440	0	0
2	0.5	4	3×2	108×2	1436	5.4936	1296	825.69	63.72
3	1	7	5×2	106×2	1314	9.4176	2120	1295.22	61.09
4	2	11	7×2	104×2	1232	14.1264	2912	1821.58	62.55
5	2.2	14	8×2	102×2	1104	18.5213	3264	2295.29	7032

Title :

Date : 5/8/24
Page No. : 24

Theory :

The brake test is a direct load test. The DC machine under test is a compound motor provided with a brake drum. There is a suitable arrangement for loading the motor mechanically.

The DC motor is started under noload taking neccessary precautions by applying rated voltage V_s. It is brought to its rated speed. It is then loaded. Loading is gradually increased and for each load ammeter, voltmeter, spring balance readings and speed are noted. Loading is continued till motor draws rated current from supply mains. The motor is shut-down. By finding circumference the radius of the brake drum is computed.

Input power = $V_s I_L$ watts. where V_s is the supply voltage in volts.

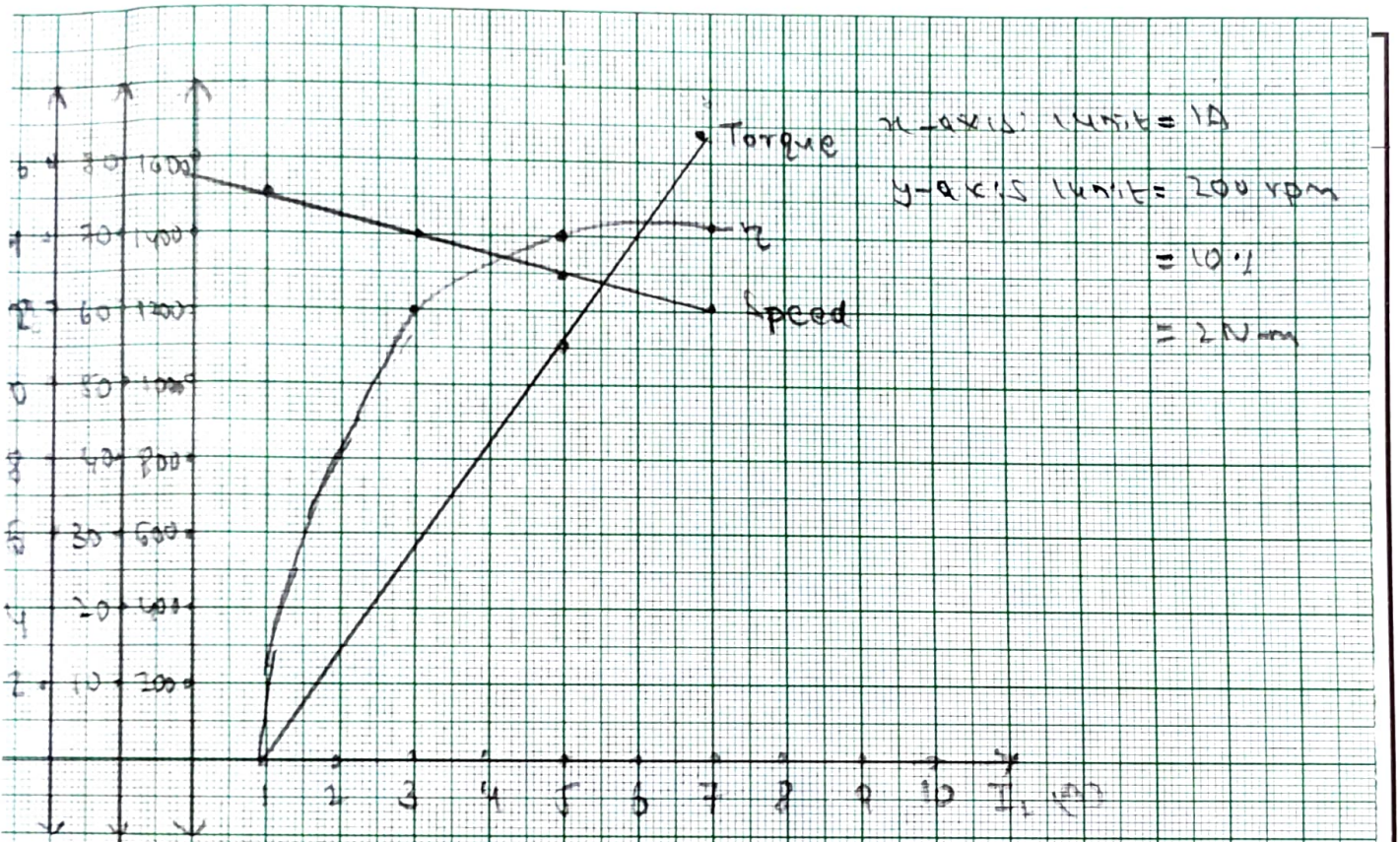
I_L is the Line current in amperes.

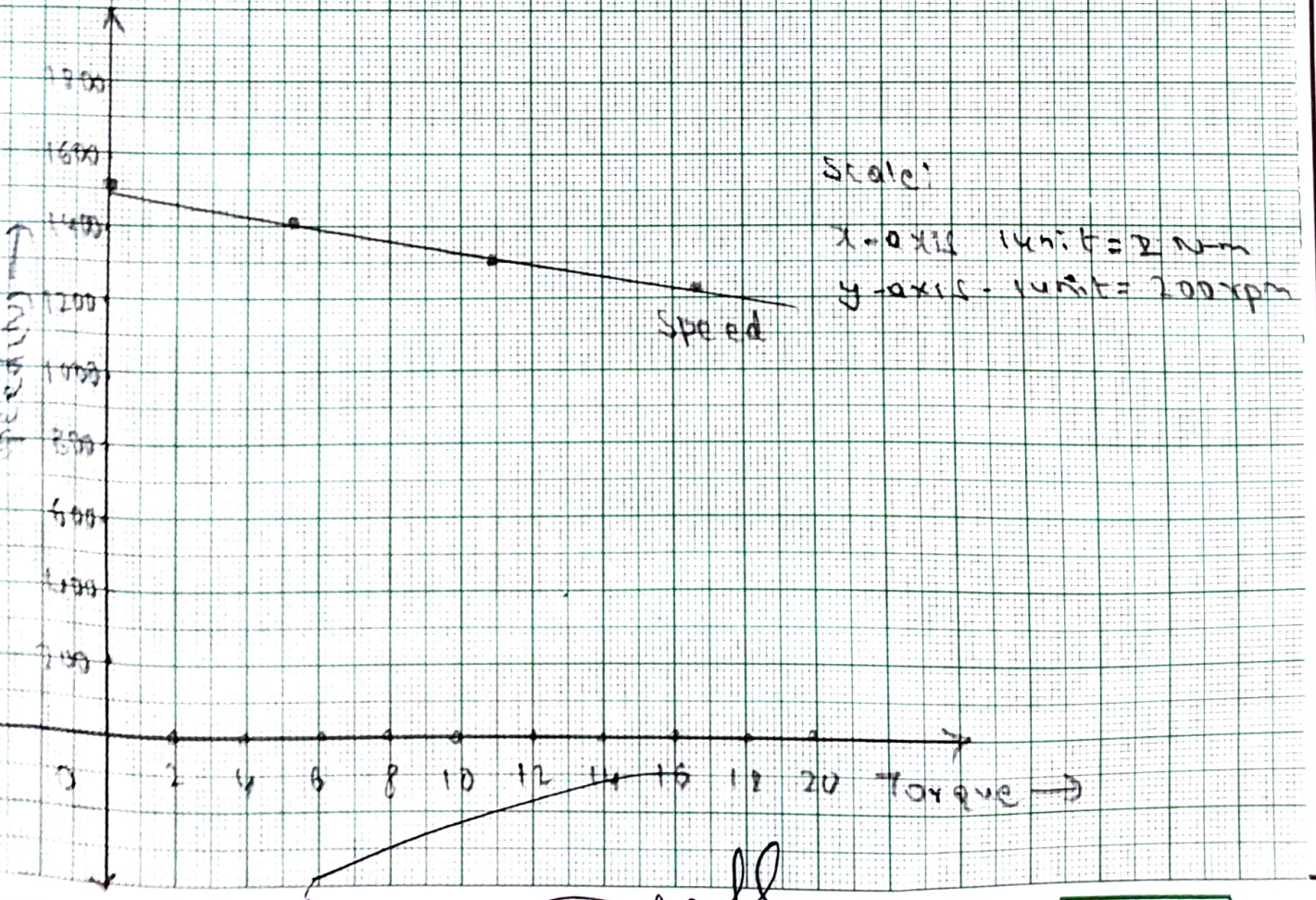
Output power = $\frac{2\pi NT}{60}$ where N is speed rpm.
T is Torque in N-m.

Procedure :

1. Connect the Circuit as per the Circuit diagram.
2. Keep armature rheostat in maximum position and Field rheostat at minimum position.
3. Switch on the DC supply and start the motor with the help of 4-point starter.
4. Now adjust the motor speed to rated value, with the help of armature rheostat, if rated speed is not reached then adjust the Field rheostat.
5. Note down the no-load readings of voltmeter, Ammeter and also speed of the motor.
6. Now vary the load in steps by using load arrangement to rated current of the motor and at each step note down the readings of Voltmeter, Ammeter, loads and also speed of the motor.

Brake Test on DC Compound Generator





10/04/2024

7. Remove the load slowly to zero position and switch OFF the DC supply by making all devices to initial position.

Precautions:

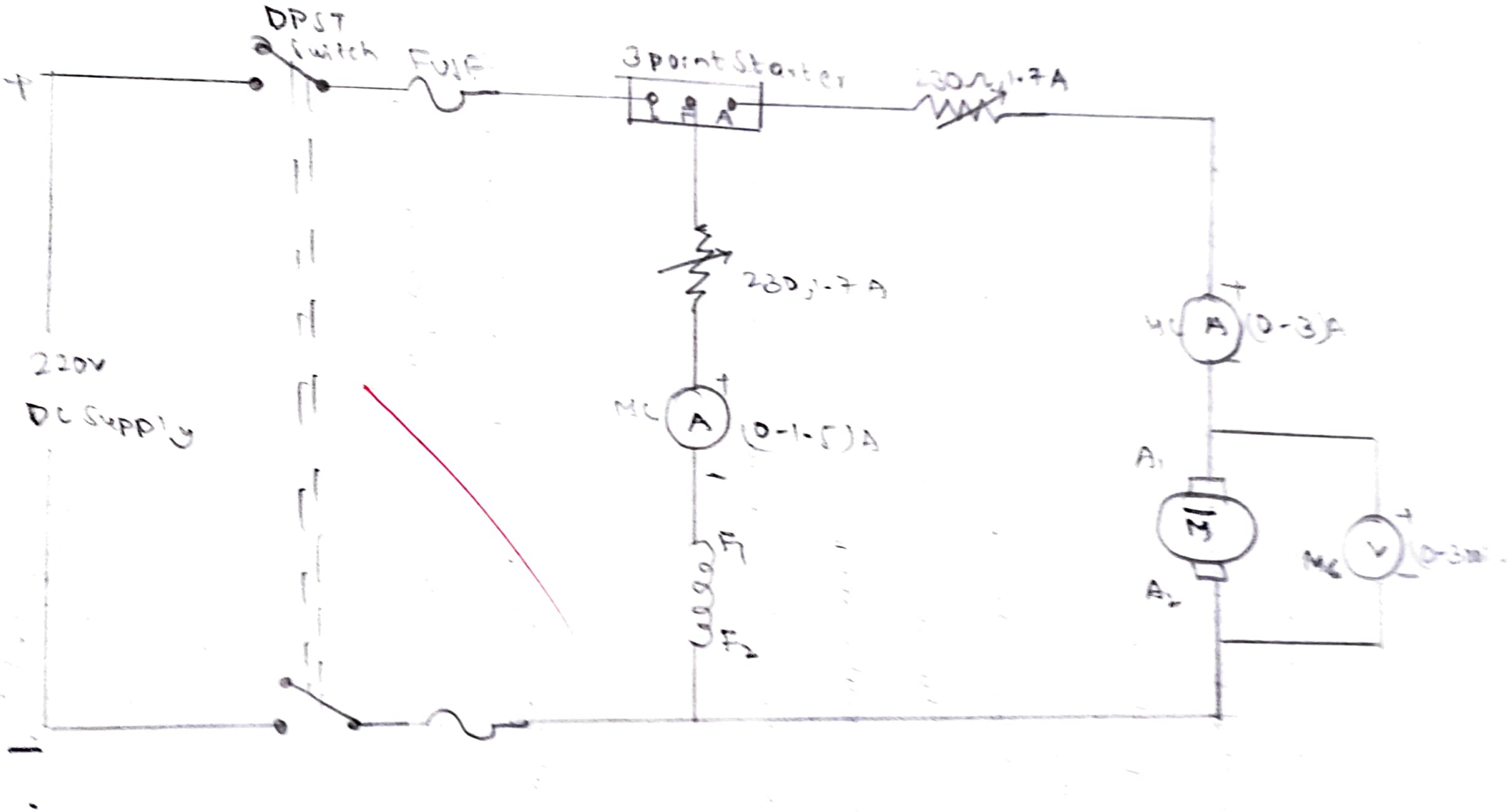
1. Connections should be neat and tight.
2. Before starting of the motor water should be poured into brake drum.
3. Note down the readings without any parallax error.

Result:

Break test on DC Compound motor and its characteristics are verified / determined.

A+

Circuit Diagram:



Title : Separation of Losses in DC Shunt Motor

Date : 10/8/21
Page No. : 27

[Apparatus Required]

Aim:

To Separate Stray losses in a DC Shunt Motor.

Apparatus Required:

1. Voltmeter	(0-300)V	MC	1No
2. Ammeter	(0-1.5)A	MC	1No
	(0-3) A	MC	1No
3. Rheostat	230Ω, 1.7A		2No's
4. Tachometer	Analog/Digital		1No.

Name Plate Details:

DC Shunt Motor:

K.W: 5

Voltage: 220V

Current: 20A

Speed: 1500rpm

Excitation Current: 1.2A

Excitation Voltage: 220V

Fuse rating Calculation

Full Load →

$\frac{125}{100} \times 20 = 25\ A$

No Load →

$\frac{20}{100} \times 20 = 4A$

Procedure:

Observation Table:

At Normal Field Current

S.NO	E_b (Volts)	I_a (Amps)	N (rpm)	W_s (Watts)	$\frac{W_s}{N}$	W_h (Watts)	W_e (Watts)	W_f (Watts)	W_o (Watts)
1	108×2	0.36×2	1500	164.16	0.109	40.5	19.5	91.10	126
2	100×2	0.38×2	1400	152	0.108	37.8	18.2	79.3	10.9
3	92×2	0.39×2	1300	132.45	0.101	35.1	16.9	68.4	9.42
4	80×2	0.34×2	1108	108.8	0.09	29.9	14.4	49.7	6.89
5	63×2	0.31×2	891	78.2	0.08	24.05	11.58	32.7	4.45
6	44×2	0.37×2	650	47.52	0.09	17.55	8.45	14.1	2.37

At 3/4th of Normal Field Current

S.NO	E_b (Volts)	I_a (Amps)	N (rpm)	W_s (watts)	$\frac{W_s}{N}$	W_h (watts)	W_e (watts)	W_f (watts)	W_o (watts)
1	107×2	0.26×2	1612	154.04	0.095	27.4	61.9	20.9	14.57
2	91×2	0.35×2	1358	27.04	0.093	23.08	43.8	17.0	10.34
3	74×2	0.38×2	1102	91.76	0.08	18.7	28.9	14.32	6.8
4	64×2	0.29×2	936	74.74	0.07	15.9	20.9	12.10	4.91
5	45×2	0.27×2	694	48.8	0.07	11.7	11.40	9.02	2.7

Title :

Date : 18/8/21
Page No. : 28

Theory:

The various losses that occur in a DC shunt machine are:

Copper Losses:

a) $I_a^2 R_a$ the armature copper

b) Loss due to brush contact resistance.

Stray Losses:

a) Iron Losses: Hysteresis loss & Eddy Current Loss.

b) Mechanical Losses: Friction at bearing and commutator, windage of rotating armature.

Iron Losses:

Iron Losses are a function of both flux and Speed

Hysteresis Losses:

The hysteresis loss P_h is a measure of the electric energy required to overcome the retentivity of the iron in the magnetic flux path, using watts as unit $P_h = k_h B^x F V$.

Eddy Current Losses: These losses occur not only in the dynamo iron but in all conductive materials with the flux path of the rotating or varying MF of the dynamo.

Calculations:

$$\frac{A}{A'} = \left(\frac{I_{f1}}{I_{f2}}\right)^{1.6} = \left(\frac{1.2}{0.9}\right)^{1.6} = 1.584$$

A → 1.584 A' → Sub A Value

$1.584A' - A' = 0.01$ — (1)

$0.584A' = 0.01 \Rightarrow A' = \frac{0.01}{0.584}$

$A' = 0.017$ — (2)

Sub eq (2) in $A' + C$

$A' + C = 0.03 \Rightarrow C = 0.03 - 0.017$

$C = 0.013$ — (3)

Sub eq (3) in $A + C$

$A + C = 0.04 \Rightarrow A = 0.04 - 0.013$

$A = 0.027$ — (4)

M Slope line → (B+D)

$M = \frac{y_2 - y_1}{x_2 - x_1}$ = (650, 0.07) (1300, 0.1)

x_1 y_1 x_2 y_2

$M = \frac{0.01 - 0.07}{1300 - 650}$ $B + D = 4.61 \times 10^{-5}$

Similarly B'+D line

(1102, 0.08) (1612, 0.095)

x_1 y_1 x_2 y_2

$M = \frac{0.095 - 0.08}{1612 - 1102}$

$B' + D = 2.941 \times 10^{-5}$

Now,

$B + D = 4.61 \times 10^{-5}$

$B' + D = 2.941 \times 10^{-5}$

$B - B' = 1.668 \times 10^{-5}$

$\frac{B}{B'} = \left(\frac{1.2}{0.9}\right)^2 = 1.7$

$B = 1.78$

Sub B in $(B - B')$

$1.7B' - B' = 1.669 \times 10^{-5}$

$0.7B' = 1.669 \times 10^{-5}$

$B' = 2.38 \times 10^{-5}$

$B - (2.38 \times 10^{-5}) = 1.669 \times 10^{-5}$

$B = 4.049 \times 10^{-5}$

$D = 4.61 \times 10^{-5} - 4.049 \times 10^{-5}$

$D = 5.61 \times 10^{-6}$

at Normal Field Current of 1500rpm

$\omega_s = E_b \times I_a = 108 \times 2 \times 0.76$

$\omega_s = 164.16 W$

$\frac{\omega_s}{N} = \frac{164.16}{1500} = 0.109$

$\omega_4 = 40.5 W$

$\omega_F = CN = 0.013 \times 1500$

$\omega_F = 19.5$

$\omega_c = BN^2 = 91.10 W$

$\omega_w = DN^2 = 12.625 W$

Title :

Date : 10/8/21
Page No. : 29

Procedure:

1. Connect the circuit as per the circuit diagram.

2. Keep armature rheostat in max position and Field rheostat at min position.

3. Switch ON the DC supply and start the motor with the helpof 3-point starter.

4. Adjust the speed of the motor to rated value with the help of armature rheostat if rated speed is not reached then adjust the Field rheostat.

5. Notedown the readings of voltmeter, ammeters and speed of the Motor.

6. Keep Field current constant at normal value and vary the speed of motor in steps to lower value vay 650rpm with the help of armature rheostat.

7. At each step note down the readings of voltmeter, ammeters and speed of motor.

8. Now again bring the motor speed to rated value with the help of armature rheostat and keep Field current constant at $3/4^{th}$ of normal value and note down the readings of Voltmeter, ammeters and Speed of motor.

9. Vary the Speed of motor in steps to lower value say 650rpm with the help of armature rheostat and at each step note down the readings of Voltmeter, ammeters and Speed of the motor.

10. Switch OFF the DC supply by making all devices to initial positions.

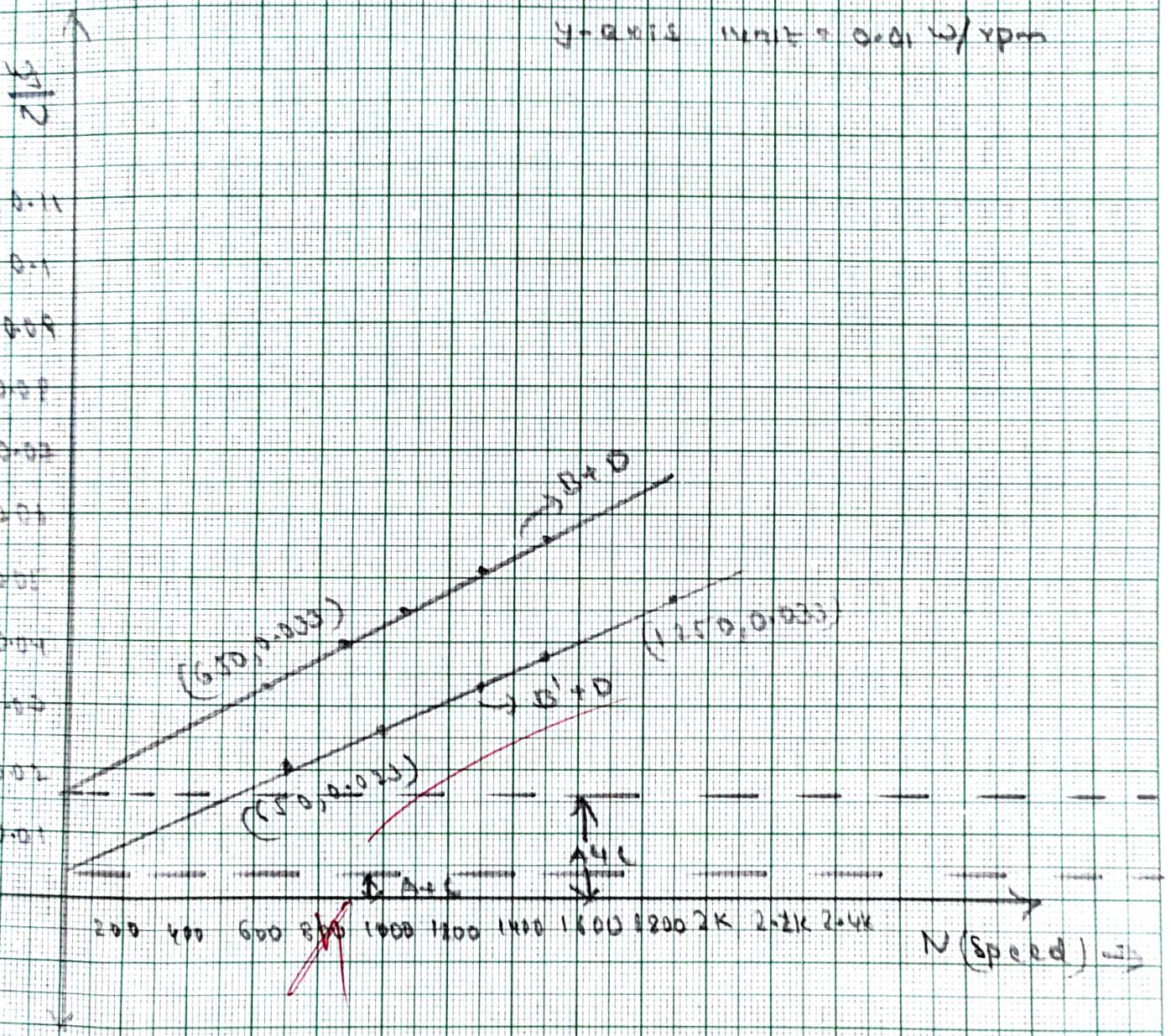
Precautions:

→ Connections should be neat and tight.

→ Note down the readings without any parallax error.

→ Before Starting of the motor check the rheostat position properly.

Separation of Losses



Title :

Date : 13/8/24
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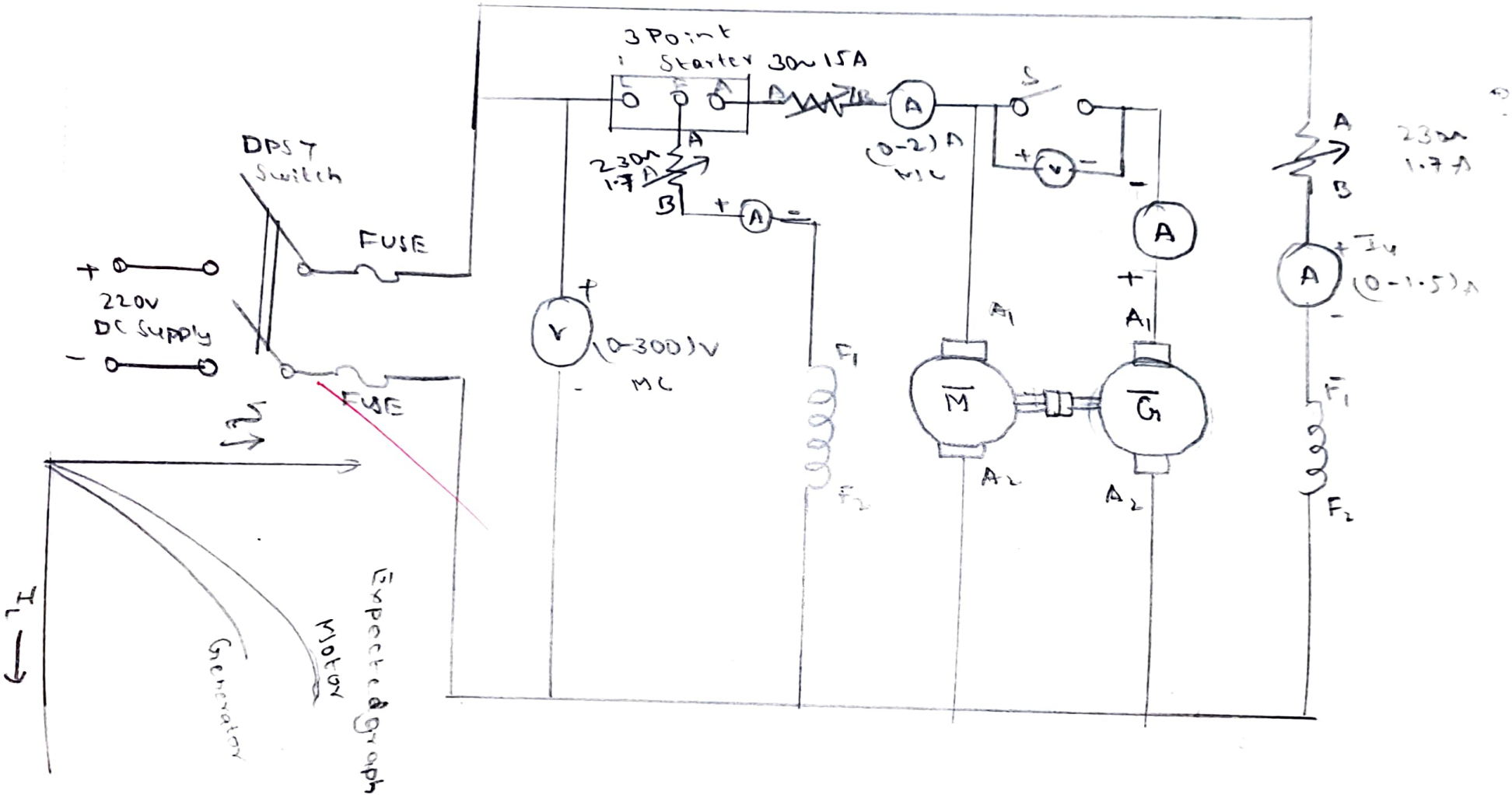
Result:

Separate stray losses in a DC Shunt motor is verified and determined and graphs were drawn.

13/8/24

Circuit Diagram



Title : Hopkinson's Test on DC Shunt machines

Date : 10/8/19
Page No. : 32

Aim:

To perform Hopkinson's test on two identical DC Shunt machines and predetermine their efficiencies.

Apparatus Required:

1.	Voltmeter	(0–300) V	MC	1No
		(0–600) V	MC	1No
2.	Ammeter	(0–20) A	MC	2No's
		(0–1.5) A	MC	2No's
3.	Rheostat	230Ω, 1.7A		2No's
		30Ω, 25A		1No
4.	Tachometer	Analog/Digital		1No
5.	Switch (SPST)	20A		1No

Name Plate Details:

DC Shunt Motor

K.W: 3.5

Voltage: 220V

Load Current: 18.6 A

Speed: 1500 rpm

Shunt Field Current: 0.9A

DC Shunt Motor.

K.W: 3.5

Voltage: 220V

Load Current: 16.8 A

Speed: 1500 rpm

Shunt Field Current: 1.2A

S.No	Voltage Volts(V)	Line Current (Amps)	I_2 (Amps)	I_3 (Amps)	I_4 (Amps)	Stray Losses (watts)	Generator losses (watts)	Motor losses (watts)	Motor Input (watts)	Generator Output (watts)	η_m (%)	η_g (%)
1	220	1.2	0	0.9	0.92	555.5	454.87	308.45	784.6	0	39.51	0
2	220	1.4	4	0.53	0.17	288.74	300.15	265.98	1304.6	820	79.6	74
3	220	2.7	8	0.51	0.51	359.28	396.36	331.98	2400.2	1760	86	77.7
4	220	3.7	1.5	0.5	0.5	395.6	501.28	528.31	3410	2512	84	80.5

Title :

Date : 10/8/24
Page No. : 33

Theory:

It is also called as regenerative or back to back test. In this method Full Load test can be carried out on two shunt machines preferably identical ones without wasting their outputs. The two machines are mechanically and electrically coupled and are so adjusted electrically that one of them runs as a motor and other runs as a generator. The mechanical output of the motor drives the generator and the electrical output of generator is used in supplying the greater part of input to the motor.

The only disadvantage is with regard to the availability of two identical machines.

Procedure:

1. Connect the circuit as per the circuit diagram.
2. Keep Field rheostat of the motor in min position

Calculations:

1) $I_1 = 1.2A$ $I_2 = 0$ $I_3 = 0.94A$ $I_4 = 0.8A$

Total Stray losses $= VI_1 - [(I_1 + I_2)^2 R_a + I_2^2 R_a]$

$= 220 \times (1.2) - [(1.2+0)^2 0.8 + 0^2 \times$

$= 535.5W$

→ motor(2):

$I/P = 220(1.2+0) + 210.94 = 764.84W$

Total Losses $= (I_1 + I_2)^2 R_a + VI_3 + \frac{W}{2} = 300.97W$

$\eta = \frac{764.64 - 308.95}{764.64} = 59.5\%$

→ η_g(generator):

$o/p = VI_L = 210 = 0$

(u losses $= 0^2 \times 0.98 + 220(0.82) + \frac{555.5}{2} = 454.87W$

$\eta = \frac{o/p}{o/p + losses} = \frac{0}{0 + 454.87} = 0$

2) $I_1 = 1.4A$, $I_2 = 4A$, $I_3 = 0.53A$, $I_4 = 0.59A$

Total stray losses $= 20(1.4) - [(1.4+4)^2 + 0.08) + 4^2 \times 0.4$

$= 288.74W$

motor(2):

$I/p = V(I_1 + I_2) + VI_3 = 220(1.4+4) = 220(0.53) = 1304W$

Total losses $= (1.4+4)^2(0.48) + 220(0.53) + \frac{288.74}{2}$

$= 265.81W$

$\eta = \frac{1304.6 - 265}{1304.6} = 79.6\%$

and armature rheostat of the motor in maximum position and also keep Field rheostat of the generator in maximum position.

3. Switch on the DC supply and start the M-G set with the help of 3-point starter.

4. Adjust the M-G set speed to rated value with the help of armature rheostat of the motor. If the rated speed is not reached then adjust the Field rheostat of the motor.

5. Adjust the Field rheostat till voltmeter(V_1) reads zero volts.

6. When voltmeter V_1 reads zero volts close the switch 'S'.

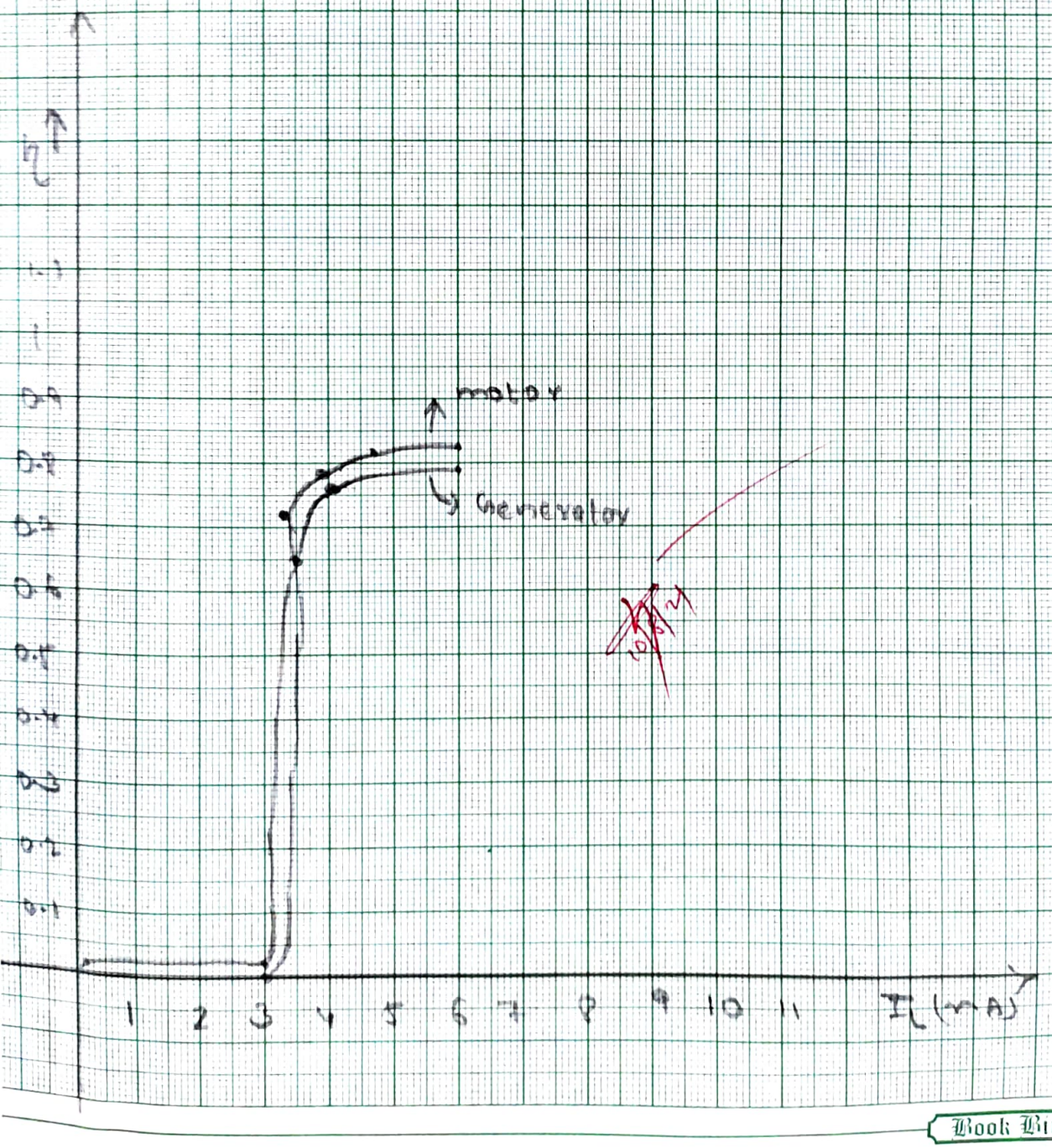
7. Now, increase the Field current of the generator in steps with the help of Field rheostat of the generator to rated current and at same time decrease the Field current of the motor with the help of Field rheostat of the motor to maintain constant speed.

Hopkinson's Test

Scale:

x-axis 1 unit = 1 A

y-axis 1 unit = 0.1 V



8. At each step note down the readings of Voltmeter, and Ammeter.

9. Switch OFF the DC supply by making all devices to initial position.

Precautions:

1. Connections should be neat and tight.

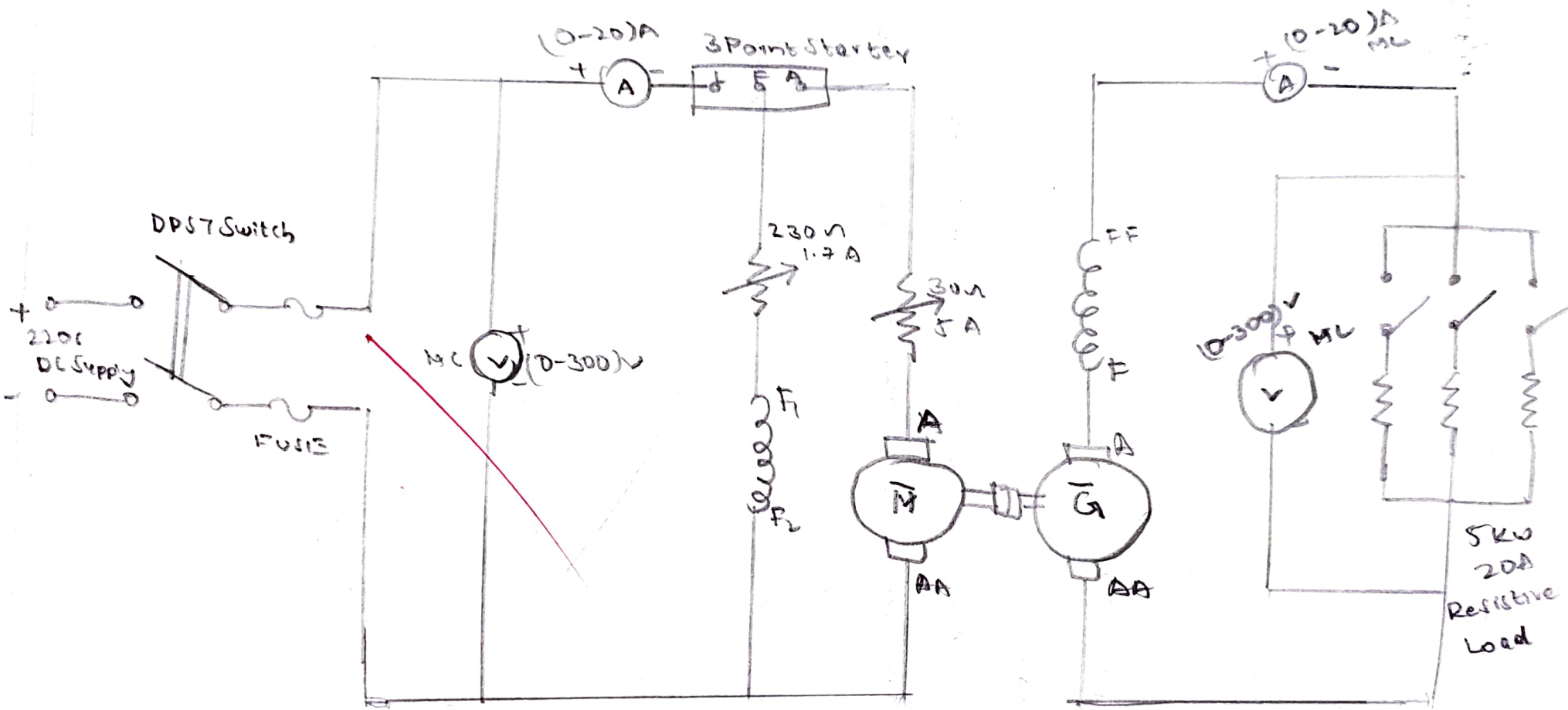
2. Before starting of the M-G set check the positions of the rheostats and also switch.

3. Note down the readings without any parallax error.

Result:

Hopkinson's Test on two Identical DC Shunt machines are verified and efficiencies are Predetermined.

Circuit Diagram :



Title: Load Test on DC Series Generator

Date 10/8/21

Page No.: 36

Aim:

To perform Load Test on DC Series Generator and determine its Internal and External Characteristics

Apparatus Required:

1. Voltmeter	(0-300) V	MC	2 No's
2. Ammeter	(0-20) A	MC	2 No's
3. Resistive load	5KW, 20A		1 No
4. Rheostat	230Ω, 1.7A		1 No
	30Ω, 15A		1 No
5. Tachometer	Analog / Digital		1 No

Name Plate Details:

DC Shunt Motor

K.W: 5KW

Voltage: 220V

Current: 20 A

Speed: 1500rpm

Excitation Current: 1.1A

Excitation Voltage: 220V

DC Series Generator:

K.W: 3KW

Voltage: 220V

Current: 11A

Speed: 1500rpm

Excitation Current: 1.1A

Excitation Voltage: 220V

Observation Table

S.NO	V_m (V)	I_{lm} (Amps)	V_g (V)	$I_{lg} = I_{ag} - I_{leg}$ (Amps)	$I_{ag}(R_a + R_{se})$ (Volts)	E_g (V)	Input (W)	Output (W)	Efficiency (%)
1.	110×2	0.6×2	10×2=20	0	0	20	264	0	0
2	110×2	1.8×2	62×2=124	1.6×2=3.2	6.016	130.01	792	396.5	50.1
3.	110×2	3.5×2	84×2=168	3.1×2=6.2	11.65	179.65	1540	1041.6	67.63
4.	110×2	5.6×2	98×2=196	4.5×2=9	16.92	212.95	2464	1764	71.59
5.	110×2	5.9×2	110×2=220	4.7×2=9.4	17.67	217.67	2552	1880	73.66
6.	110×2	6.5×2	110×2=220	4.8×2=9.6	18.04	220.64	2960	1939.2	67.8

Title :

Date : 10/8/21
Page No. : 37

Theory :

The efficiencies of all DC machines can be computed in two ways : 1. Direct Test 2. Indirect Test.

In Direct method the Input and Output power can be measured by suitable means and efficiency computed as a ratio of output to input.

a) It may not be possible to provide the necessary load

b) Even if load is arranged there would be enormous power loss during the test.

Internal and External Characteristics :

If a Shunt generator is loaded its terminal voltage decreases due to armature resistance and armature and armature reaction. As the machine supplies more and more load current there is increased I_aR_a drop and greater demagnetizing effect. The combined effect is that the terminal voltage progressively decreases and diminishes with increase of load current.

For a loaded Shunt Generator $I_a = I_L + I_{sh}$

$E = V + I_aR_a$

Title :

Date : 10/8/21

Page No. : 38

Procedure:

1. Connect the Circuit as per the circuit diagram.

2. Keep Field rheostat of the motor in minimum position and armature rheostat of the motor at max position and also generator Field rheostat ~~and~~ at maximum position.

3. Switch ON the DC Supply and start the MG set with the help of 3-point Starter.

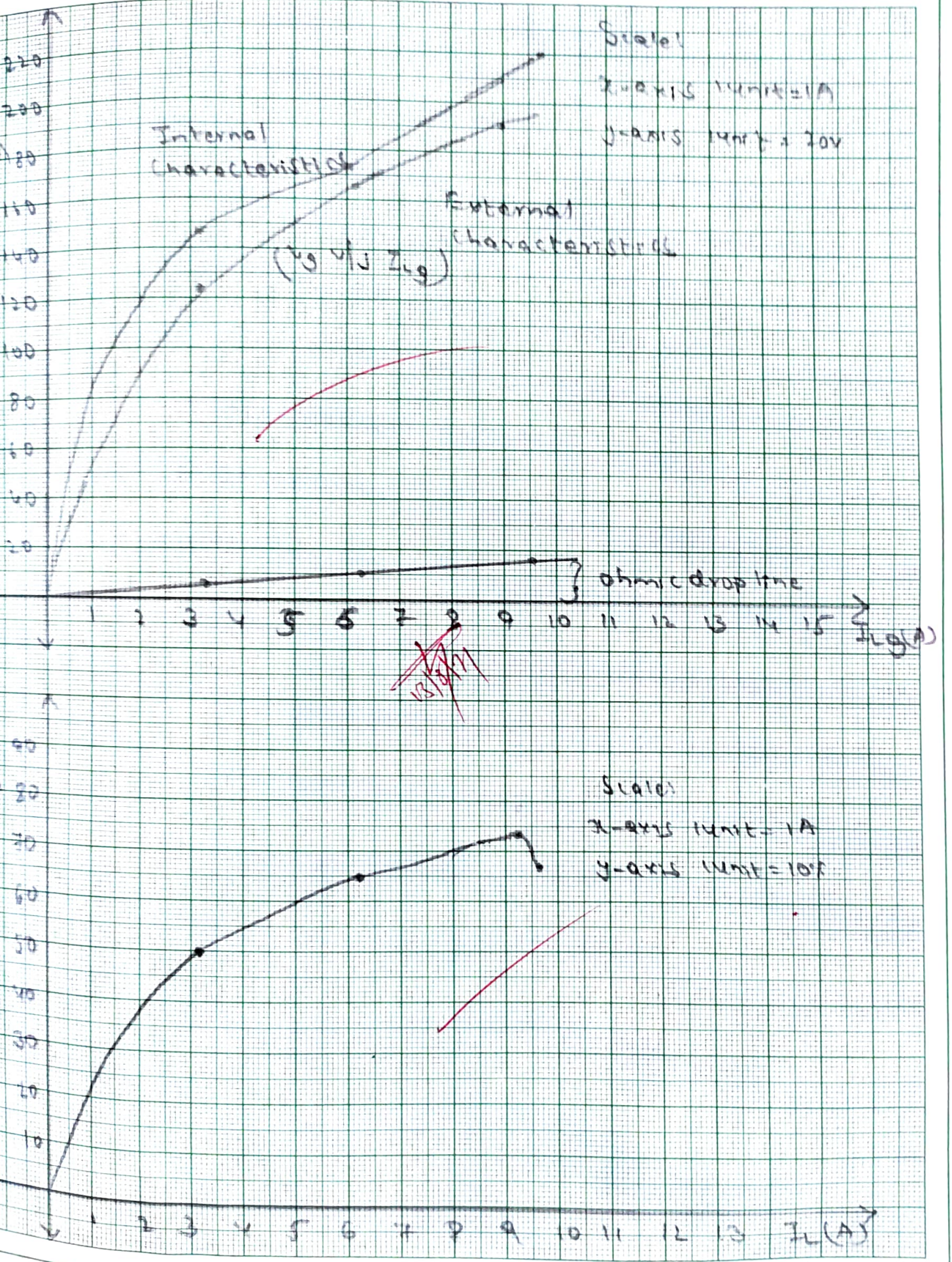
4. Adjust the MG Set Speed to rated Value with the help of armature rheostat of the motor. If rated Speed is not reached then adjust the Field rheostat of the motor.

5. Now adjust the Field rheostat of the generator to rated Voltage of the generator.

6. Note down the No-Load readings of Voltmeter and Ammeters.

7. Now vary the load in steps to rated Current of the generator and at each step note down the readings of Voltmeters and Ammeters and also at each step maintain Constant Speed with the help

DC Series Generator



of Field rheostat of the motor.

8. Switch OFF the load to zeroposition and also switch OFF DC supply by making all devices to initial position.

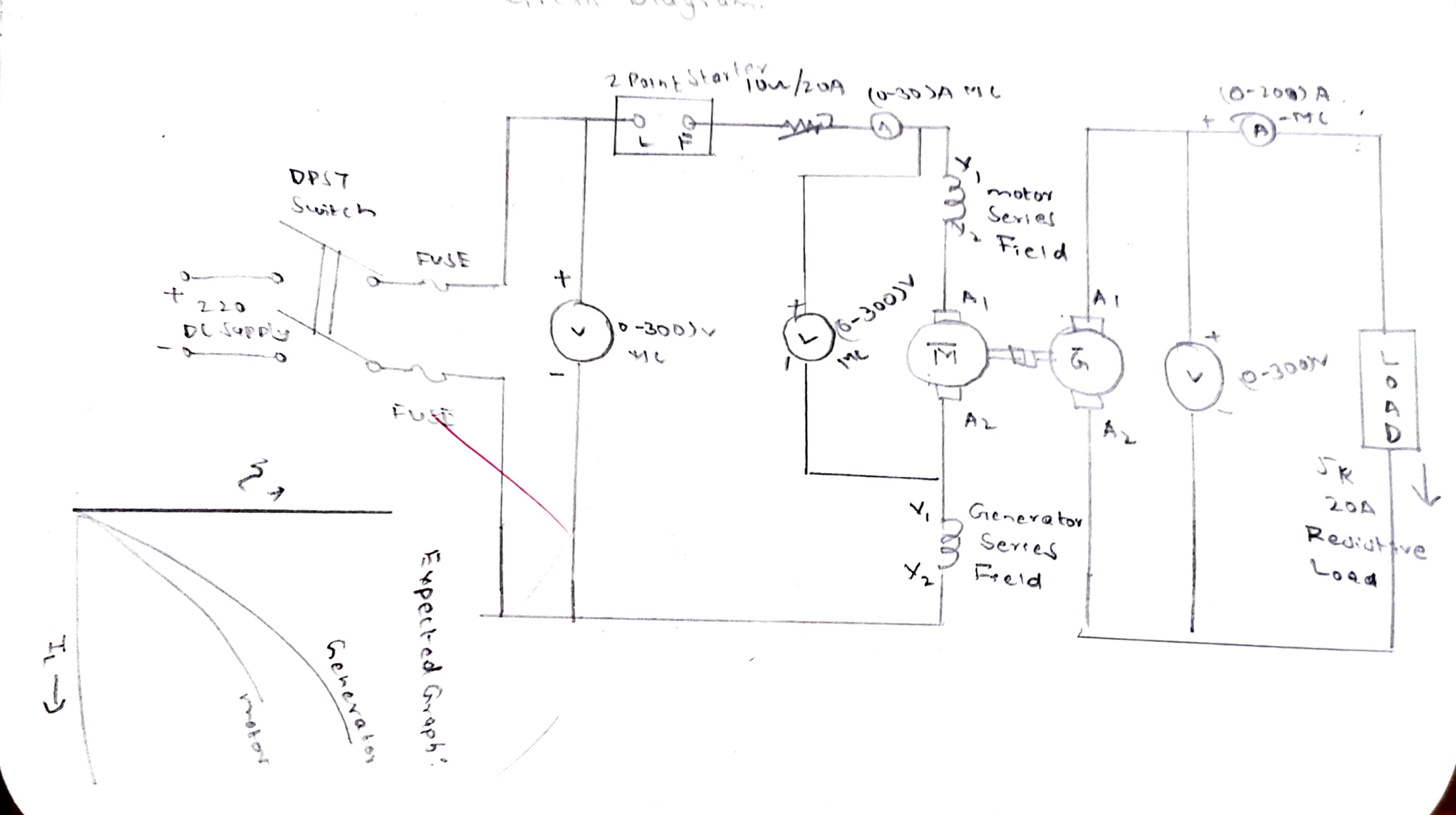
Precautions:

1. Connections should be neat and tight.
2. Before Starting of the M-G Set ensure that there is no load on the generator.

Result:

Internal and External Characteristics of load Test on DC Series generator are determined and Verified.

13/8/21


2 Point Starter 10A/20A
(0-30)A MC
(0-20)A
MC
DPST
Switch
FUSE
FUSE
220
DC Supply
(0-300)V
MC
(0-300)V
MC
motor
Series
Field
A1
A2
A1
A2
(0-300)V
LOAD
5K
20A
Resistive
Load
Generator
Series
Field
Expected Graph:
Motor
Generator

Title: Field Test ON DC Series Machines

Date : 10/8/24
Page No. : 40

Aim:

To find the efficiency of given DC Series machines.

Apparatus Required:

1.	Voltmeter	(0-250)V	MC	3 No
2.	Ammeter	(0-20)A	MC	2 No
3.	Rheostat	20Ω, 10A		1 No
4.	Resistive Load	50kw, 20A		1 No
5.	Tachometer	Analog/Digital		

Name Plate Details:

DC Series Motor:

Kw:

Voltage:

Load Current:

Speed:

Excitation Current:

Excitation Voltage:

DC Series Generator:

k.w:

Voltage:

Load Current:

Speed:

Excitation Current:

Excitation Voltage:

Input to set	Output of set	Total losses	Generator Cu losses	motor Cu losses	Stray losses of each mc	η of motor	η of generator
17442	1465	279.2	165.6	24.2	16.81	82.2	83.4

S.NO	Supply voltage (V)	voltage across voltage (V_L)	motor Input Current (I)	Load voltage (V_L)	Load Current (I_L)
1.	220V	188V	11A	161V	9.1A

Title :

Date : 10/8/21
Page No. : 41

Theory:

In a Series motor the Field and the armature are connected in Series. When the motor is switched on No-load then as the load is zero the load current is very low and speed increases rapidly. Hence it is difficult to Find the efficiency of the Series motor.

Also For a Series generator, with the increase in the load the Field Current also increases and stray losses vary with load. In Series Field test the Series Field windings of both the motor and the generator are connected in Series, so that even on increasing the load, the stray losses in both the machines are equal. This Connections makes it easy to Find the efficiency of both the motor and generator.

Title :

Date : 10/11/21
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Procedure:

1. Connect the Circuit as per the Circuit diagram as shown in Fig.

2. Keeping initially Some load on the generator Switch on the power Supply to the motor with rheostat connected in Series Field at max position.

3. Gradually Cut out the resistance So that the rated voltage is obtained across the armature terminals of the motor.

4. Now gradually apply the load on the generator until the ammeter connected in motor Circuit Shows its rated motor Current.

5. Note down the readings of voltmeter and Ammeter.

6. Switch OFF the DC Supply by making all devices to initial position.

motor η Calculation:

Power I/p of the motor $P_{in} = V_1 I_1 - I_1^2 R_{se}^2$

$= 2100 - 98.6 = 2003.2W$

Total losses in the motor $(W_s) = I_1^2 R_{se} + I_1^2 R_{a,field}$

$= 96.8 + 242 + 16.85 = 355.65W$

motor O/p = $P_{in} - W_s$ = $2003.2 - 355.65 = 1647.5W$

$\% = \frac{P_{out}}{P_{in}} \times 100 = \frac{1647.5}{2003.2} \times 100 = 82.2\%$

Generator efficiency calculations:

Generator losses in generator: $W_s + I_1^2 R_{se_2} + I_2^2 R_a$

$= 16.85 + 96.5 + 165.6 = 279.25W$

Power I/p to the generator (P_{in}) = $P_{out} + 279.25$

$= 1465 + 279.25$

$= 1744.25W$

% η of the generator = $\frac{P_{out}}{P_{in}} \times 100$

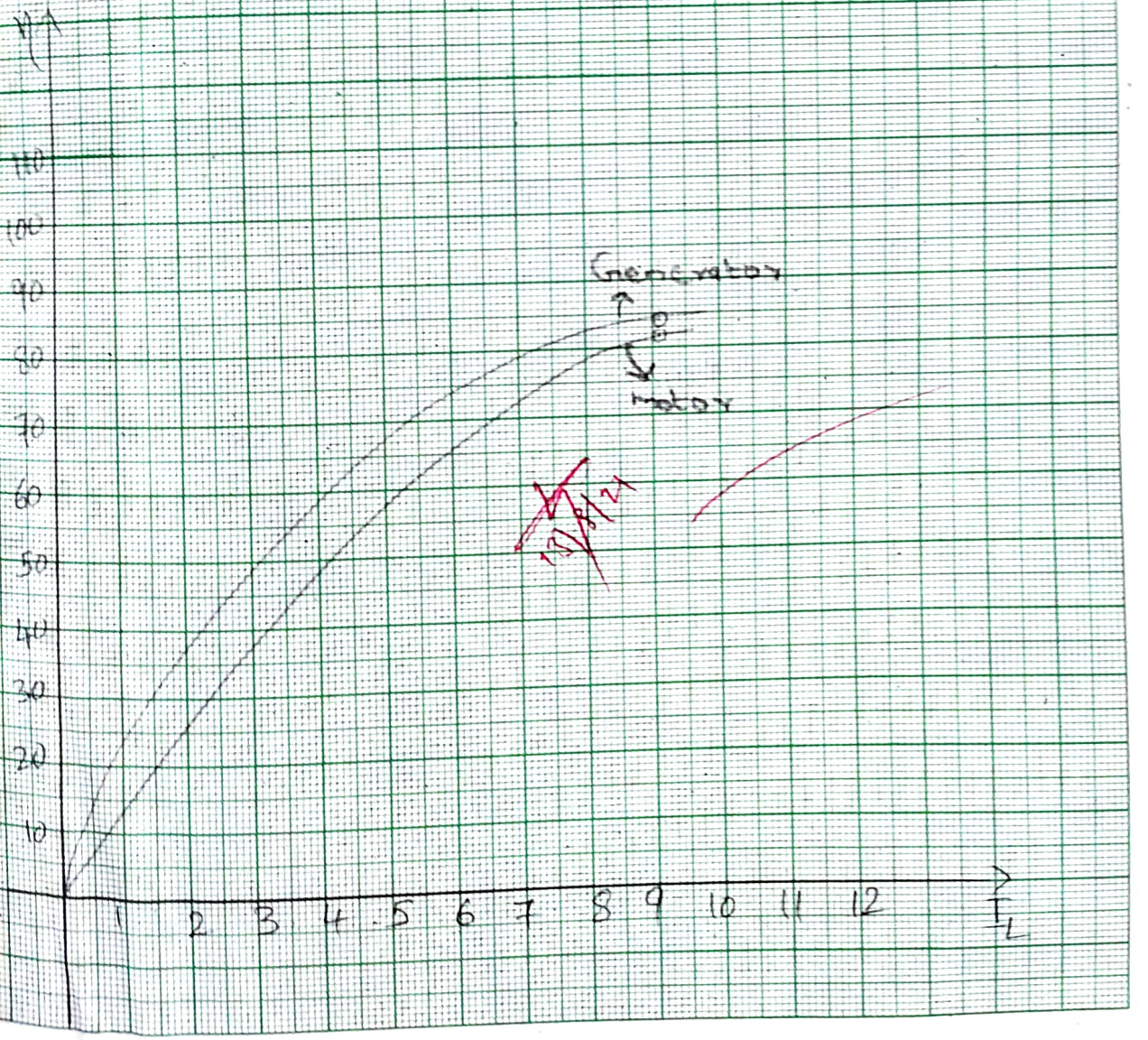
$= \frac{1465}{1744.25} \times 100 = 83.9\%$

Field Test

Scale:

x-axis unit: 1 A

y-axis unit: 10 %



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Precautions:

1. The motor rheostat should be kept at maximum resistance position.

2. All the motor reading must be taken without parallazes error.

3. The power supply should be given to the motor with some initial load applied across the generator only.

Result:

The efficiency of DC series machines of Field test is determined and verified.