LABORATORY DEMONSTRATION

ON

DC MACHINES AND TRANSFORMERS

(20A02302P)

By

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Professor

Department of EEE

VEMU IT ,CHITTOOR

Vision of the Institute

To be a premier institute for professional education producing dynamic and vibrant force of technocrat with competent skills, innovative ideas and leadership qualities to serve the society with ethical and benevolent approach.

Mission of the Institute

Mission_1: To create a learning environment with state-of- the art infrastructure, well equipped laboratories, research facilities and qualified senior faculty to impart high quality technical education.

Mission_2: To facilitate the learners to foster innovative ideas, inculcate competent research and consultancy skills through Industry-Institute Interaction.

Mission_3: To develop hard work, honesty, leadership qualities and sense of direction in rural youth by providing value based education.

Vision of the Department

To produce professionally deft and intellectually adept Electrical and Electronics Engineers and equip them with the latest technological skills, research & consultancy competencies along with social responsibility, ethics, Lifelong Learning and leadership qualities.

Mission of the Department

Mission_1: To produce competent Electrical and Electronics Engineers with strong core knowledge, design experience & exposure to research by providing quality teaching and learning environment..

Mission_2: To train the students in emerging technologies through state - of - the art laboratories and thus bridge the gap between Industry and academia.

Mission_3: To inculcate learners with interpersonal skills, team work, social values, leadership qualities and professional ethics for a holistic engineering professional practice through value based education

Programme Educational Objectives (PEOs)

PEO_1: Provide sound foundation in mathematics, science and engineering fundamentals to analyze, formulate and solve complex engineering problems.

PEO_2: Have multi-disciplinary Knowledge and innovative skills to design and develop Electrical & Electronics products and allied systems.

PEO_3: Acquire the latest technological skills and motivation to pursue higher studies leading to research.

PEO_4: Possess good communication skills, team spirit, ethics, modern tools usage and the life-long learning needed for a successful professional career.

PO_1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_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.

PO_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.

PO_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.

PO_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.

PO_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.

PO_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.

PO_8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_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.

PO_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.

PO_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.

Programme Specific Outcome(PSOs)

PSO_1: Higher Education: Apply the fundamental knowledge of Mathematics, Science, Electrical and Electronics Engineering to pursue higher education in the areas of Electrical Circuits, Electrical Machines, Electrical Drives, Power Electronics, Control Systems and Power Systems.

PSO_2: Employment: Get employed in Public/Private sectors by applying the knowledge in the domains of design and operation of Electronic Systems, Microprocessor based control systems, Power systems, Energy auditing etc.

VEMU INSTITUTE OF TECHNOLOGY::P.KOTHAKOTA

DEPT OF ELECTRICAL & ELECTRONICS ENGINEERING

II B.Tech I Semester (EEE)

DC MACHINES AND TRANSFORMERS Lab (20A02302P)

Course Objectives:

To conduct various experiments on

- DC motors and DC Generators
- The speed control techniques of DC motors.
- To conduct various experiments for testing on 1-phase transformers

Course Outcomes:

The Student will able to:

- conduct and analyze load test on DC shunt generator
- understand and analyze magnetization characteristics of DC shunt generator
- understand and analyze speed control techniques and efficiency of DC machines
- understand to predetermine efficiency and regulation of single-phase Transformers

DC MACHINES AND TRANSFORMERS Lab (20A02302P)

List of Experiments

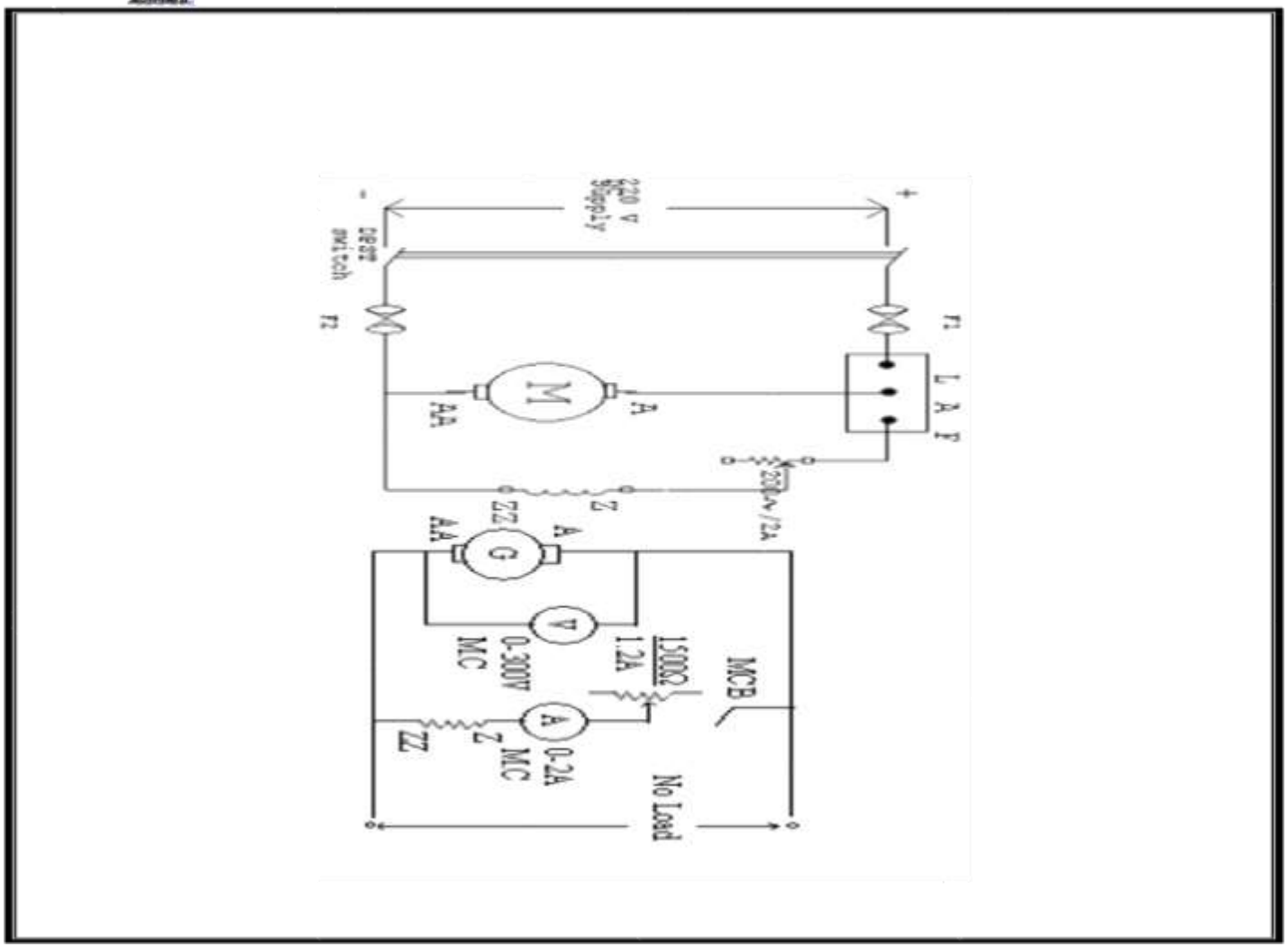
1. Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.
2. Load test on DC shunt generator. Determination of characteristics.
3. Brake test on DC shunt motor. Determination of performance curves.
4. Swinburne's test on DC shunt motor, Predetermination of efficiency.
5. Speed control of DC shunt motor (Armature control and Field control method).
6. Hopkinson's tests on DC shunt machines. Predetermination of efficiency.
7. OC and SC test on single phase transformer
8. Sumpner's test on single phase transformers.
9. Load test on DC Compound Generator (Cummulative & Differential)
10. Separation of losses in a DC shunt motor.

Additional Experiments

11. Field Test
12. Retardation Test

1.MAGNETISING CHARACTERISTICS OF DC SHUNT GENERATOR

AIM: To draw the magnetization characteristics of a self excited DC shunt generator and to determine the critical field resistance and critical speed.



OBSERVATIONS:

A. Reading to draw OCC curve (If Vs Eo).

S.NO	Increasing mode		Decreasing mode	
	If	Eo	If	Eo
1	0			
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14			0	

Critical field resistance Rc =_____Ω

critical speed Nc =_____rpm

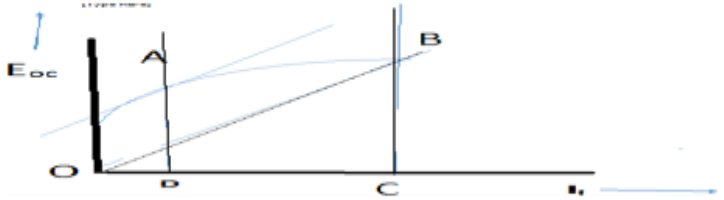
B. Readings to calculate shunt field resistance(Rsh)

S.NO	Ish in Amps	Vsh in Volts	Rsh=Vsh/Ish in Ω
1			
2			
3			
4			
5			

Average Rsh =_____Ω

Model graph:

Slope of OB-Critical field resistance (Rc)



$AD/BC=N_c/N$

$N_C= AD/BC \times N$

The conditions for satisfactory voltage build up are:

1). Presence of Residual magnetism.

2). Correct direction of rotation.

3) Field Resistance lesser than critical resistance

4) Speed more than critical speed

Critical Field Resistance:

The maximum allowed value of the field resistance to a DC shunt generator, above which the voltage fails to build up, is called the Critical Field Resistance.

Critical speed:

It is the speed below which the machine cannot build up emf.

PROCEDURE:

1. Make the connections as per the circuit diagram.
2. Ensure minimum resistance in the field circuit.
3. Switch on the supply and run the generator without load.
4. Vary the field current in steps using the field rheostat.
5. Note down the values of Field current (I_f) and Generated e.m.f. (E) at each step.

PRECAUTIONS:

1) Avoid hanging wires and loose connections.

2) Make sure that the initial value of field Resistance is minimum.

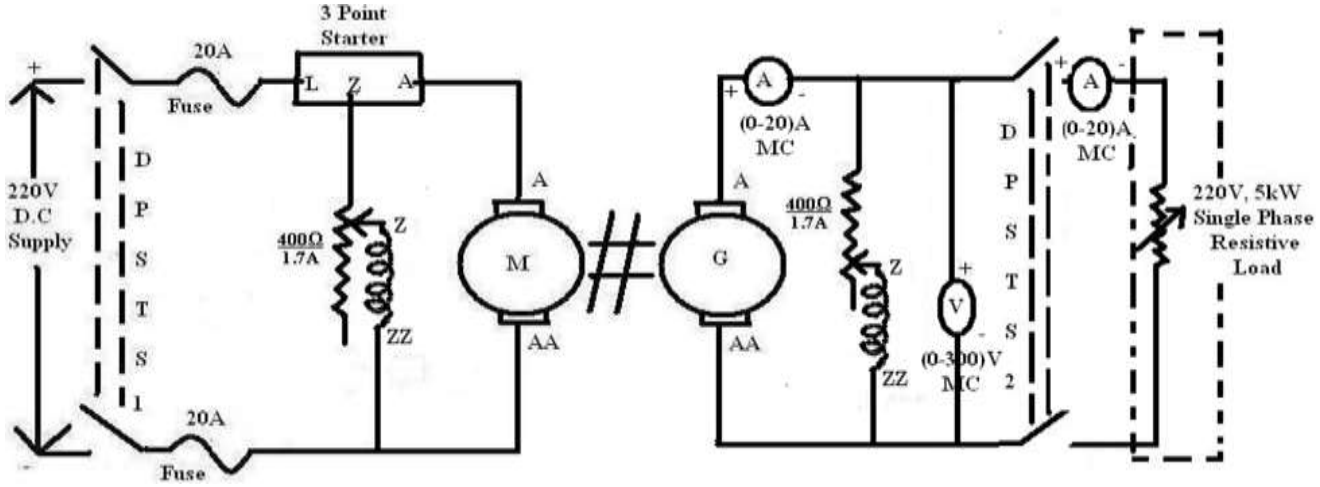
GRAPH: Draw the graph between Field current (I_f) Vs generated e.m.f (E).

2.LOAD TEST ON D.C SHUNT GENERATOR

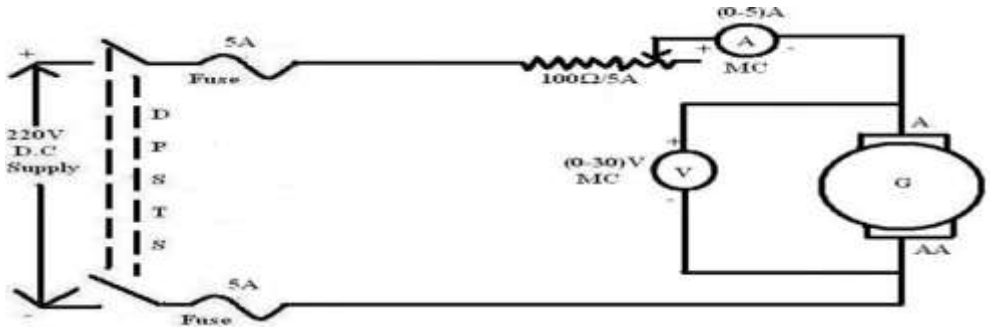
Aim:

To conduct load test on a D.C Shunt Generator and to determine the internal and external characteristics.

Circuit Diagram:



To find Armature Resistance of the Generator:



Precautions:

1. Field rheostat of the motor must be kept in minimum resistance position.
2. Field rheostat of the generator must be kept in maximum resistance position.
3. Armature rheostat of the generator must be kept in maximum resistance position.
4. DPST Switch on the generator side must be kept open.
5. Initially load must be in OFF position.
6. Starter arm must be in OFF position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the motor-generator set with the help of starter.
4. Adjust the motor field rheostat and bring the motor to its rated speed and by varying the field rheostat of the generator apply the rated voltage of the load and close the DPSTS2 switch.
5. Now load the generator in steps till maximum rated current of the generator and note down all the meter readings.
6. Observing the precautions switch OFF the supply.

To find Armature Resistance of the Generator:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat note down all the meter readings.
4. Observing the precautions switch OFF the supply.

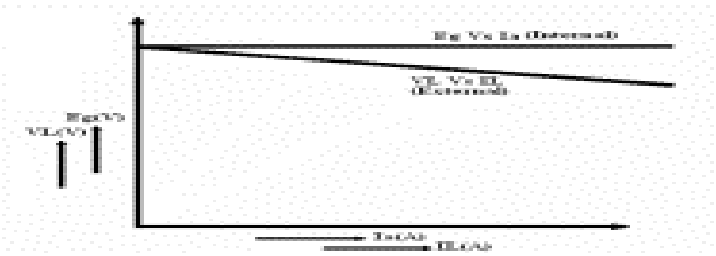
Tabular Columns:

S. No.	V (V)	I_L (A)	I_f (A)	$I_a = I_L + I_f$ (A)	$E_g = V + I_aR_a$ (V)
1					
2					
3					

To find Armature Resistance of the Generator:

S.No.	I_a (A)	V_a (V)	R_a (Ω)
1			
2			

Model Graph:



3. Brake Test on DC Shunt Motor

ELECTRICAL MACHINES LAB-I

BRAKE TEST ON D.C SHUNT MOTOR

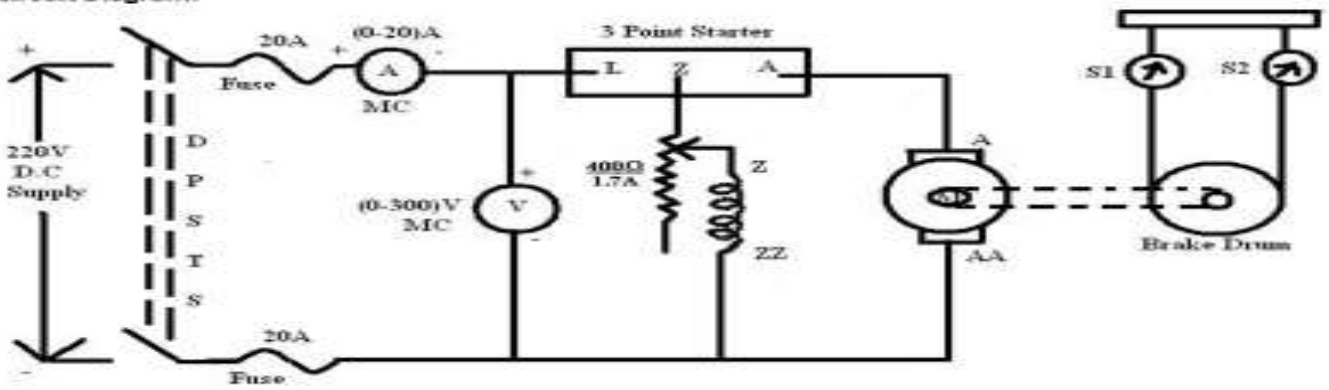
Aim:

To obtain the performance characteristics of D.C Shunt Motor by direct loading.

Apparatus:

S. No.	Name of the Equipment	Range	Type	Quantity
1	Voltmeter	(0-300)V	MC	1
2	Ammeter	(0-20)A	MC	1
3	Rheostat	400Ω/1.7A	Wire Wound	1
4	Tachometer	(0-9999)rpm	Digital	1
5	Connecting Wires	-	-	Required Some

Circuit Diagram:



Precautions:

1. Motor field rheostat must be kept in minimum resistance position.
2. Starter arm must be in OFF position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions switch ON 220V D.C supply.
3. Start the motor with the help of the starter.
4. By adjusting the motor field rheostat bring the motor to its rated speed.
5. Now load the motor in steps to its full load and note down all the meter readings.
6. Observing the precautions switch OFF the supply.

Tabular Column:

S. No.	V_L (V)	I_L (A)	N (rpm)	Spring Balance Reading			Torque (N-m)	Input (kW)	Output (kW)	ɳ (%)
				S_1	S_2	S_1-S_2				
1										
2										
3										
4										
5										
6										

Formulae:

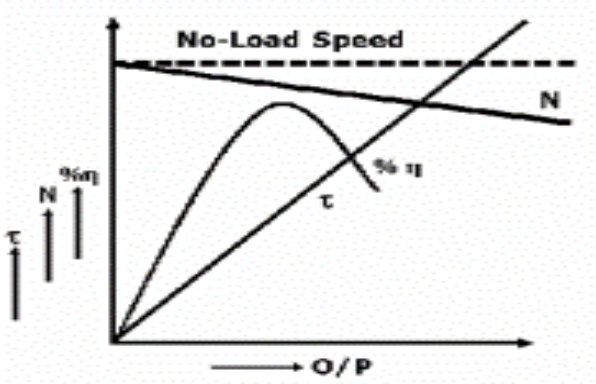
Torque = 9.81 X (S_1-S_2) X R N-m

Input = V_L I_L kW

Output = (2∏N)τ/60 kW

Efficiency = ɳ % = (Output/Input) X 100

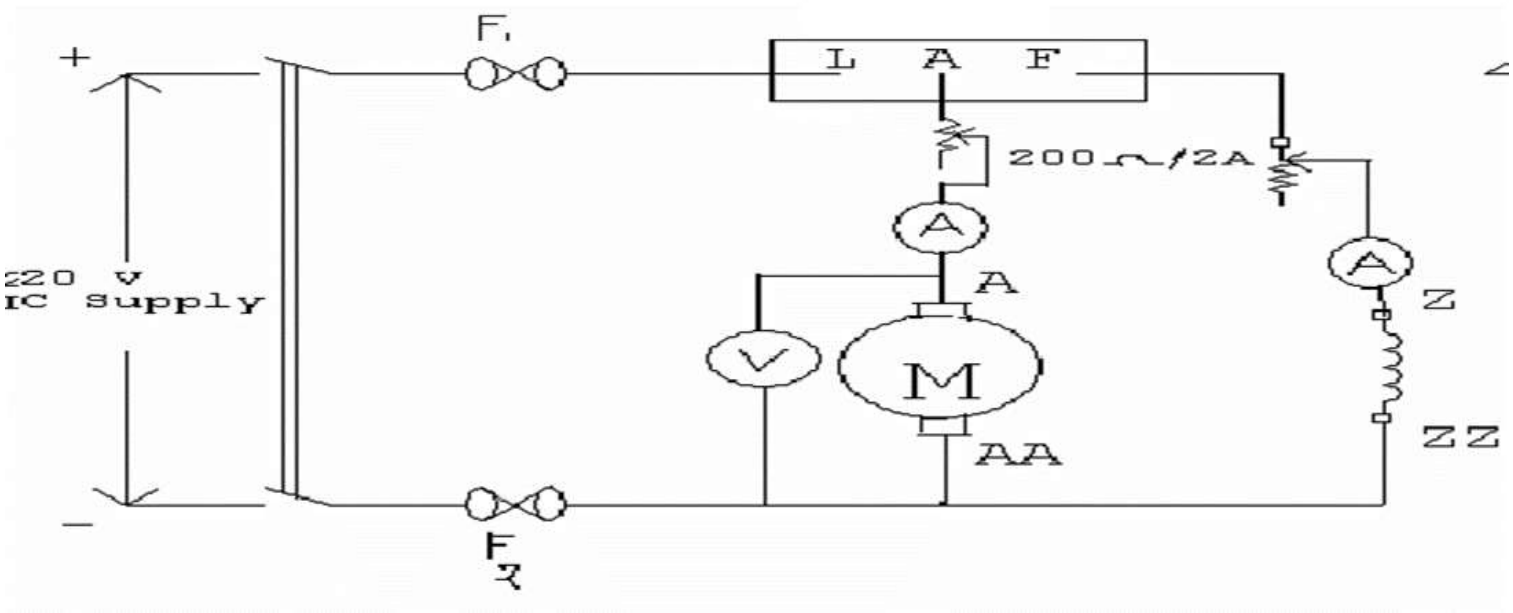
Model Graph:



Result:

4. Swinburne's Test

Aim: To predetermine the efficiency of a D.C Shunt Machine when run both as generator and motor.



Precautions:

1. Field rheostat must be kept in minimum resistance position.
2. Armature rheostat must be kept in maximum resistance position.
3. SPST Switch must be kept in closed position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Adjust the speed of motor to its rated value by adjusting field and / or armature rheostat.
4. Now open the SPST Switch & note down all the meter readings.
5. Observing the precautions switch OFF the supply.

To find Armature Resistance:

1. Connect the circuit as shown in circuit diagram.
2. Keeping the rheostat in its maximum resistance position close the DPST Switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat for different values of current note down the meter readings.
4. Observing the precautions switch OFF the supply.

Tabular Columns:

S. No.	1. Supply Voltage (V)	Line Current I_L (A)	Shunt Current I_f (A)
1			

Machine when run as Motor:

S. No.	Voltage (V)	I_L (A)	I_f (A)	I_a (A)	Input (W)	W_{Cu} (W)	W_C (W)	Output (W)	Ŋ (%)	W_T
1										
2										
3										
4										

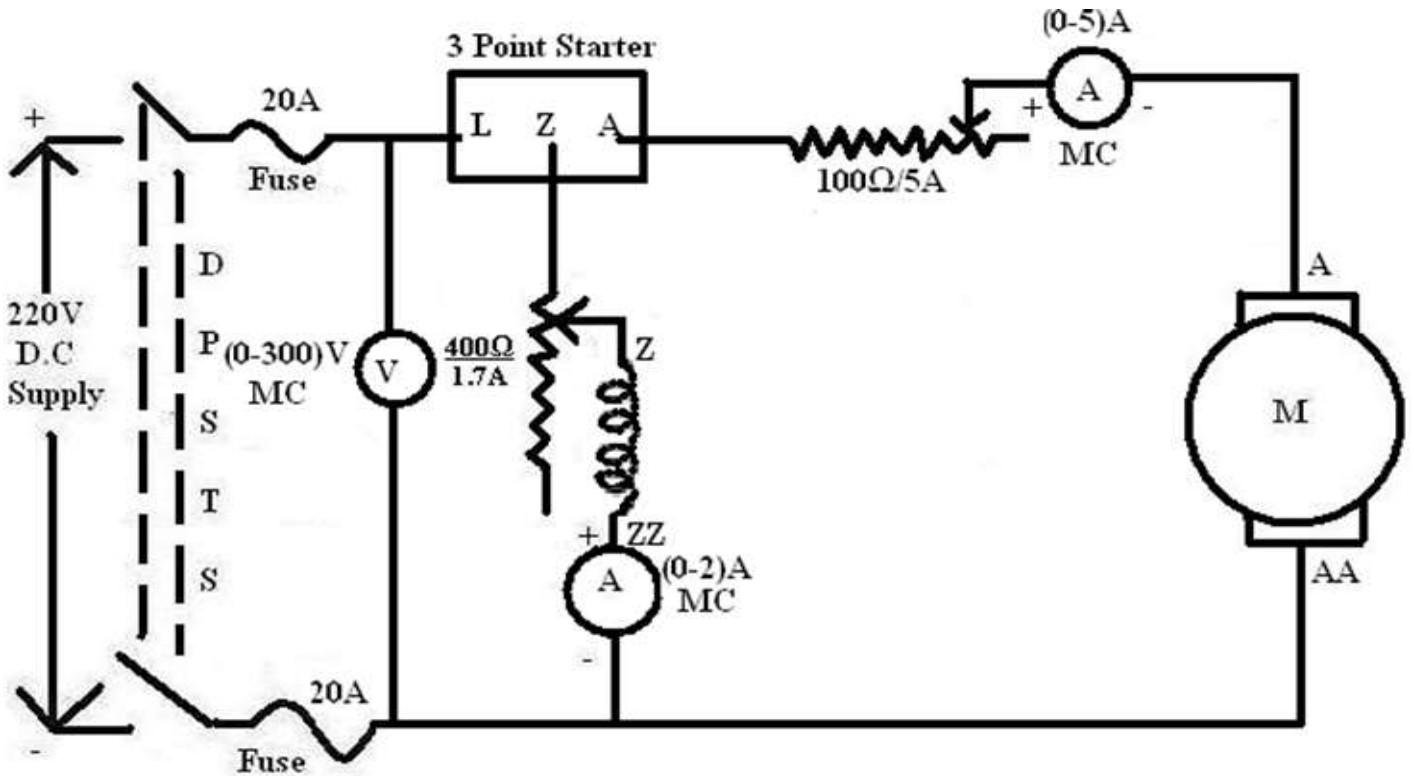
Machine when run as Generator

S. No.	Voltage (V)	I_L (A)	I_f (A)	I_a (A)	Input (W)	W_{Cu} (W)	W_C (W)	Output (W)	Ŋ (%)	W_T
1										
2										
3										
4										

5.SPEED CONTROL OF A D.C SHUNT MOTOR

Aim: To obtain the speed characteristics of D.C Shunt Motor by
1.Armature Controlled Method. 2.Field Controlled Method.

Circuit Diagram:



Procedure:

Armature Controlled Method:

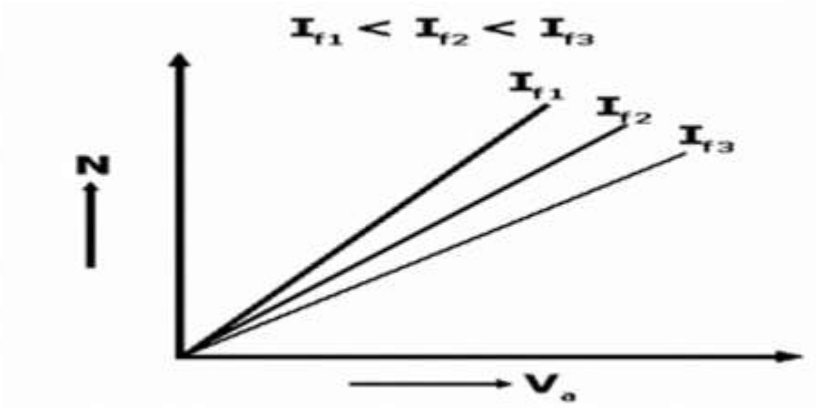
1.Connect the circuit as shown in circuit diagram.
2.Observing the precautions switch ON 220V D.C supply.
3. Start the motor with the help of starter.
4.By adjusting the field rheostat set the field current to a constant value.
5.By adjusting the armature rheostat for an armature voltage note down the speed and voltmeter readings.
6.Repeat step 5 for another constant field current.

Field Controlled Method:

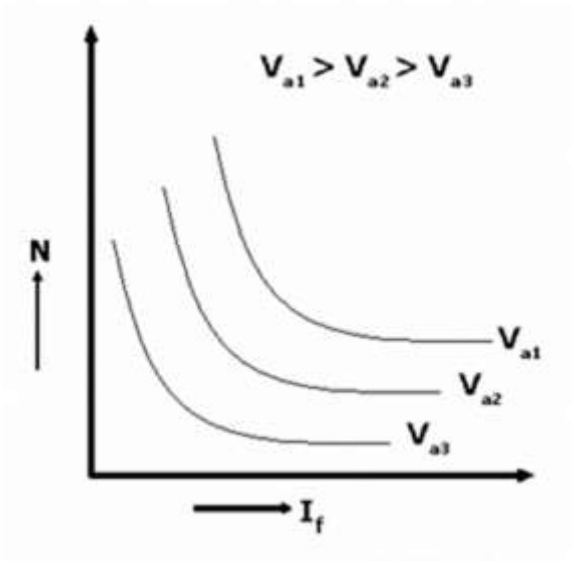
1.By adjusting the armature rheostat set the voltage to a constant value.
2.By adjusting the field rheostat for a field current note down the speed and armature current readings.
3.Repeat the above step for another constant armature voltage.

Model Graphs

Armature Controlled Method:



Field Controlled Method:

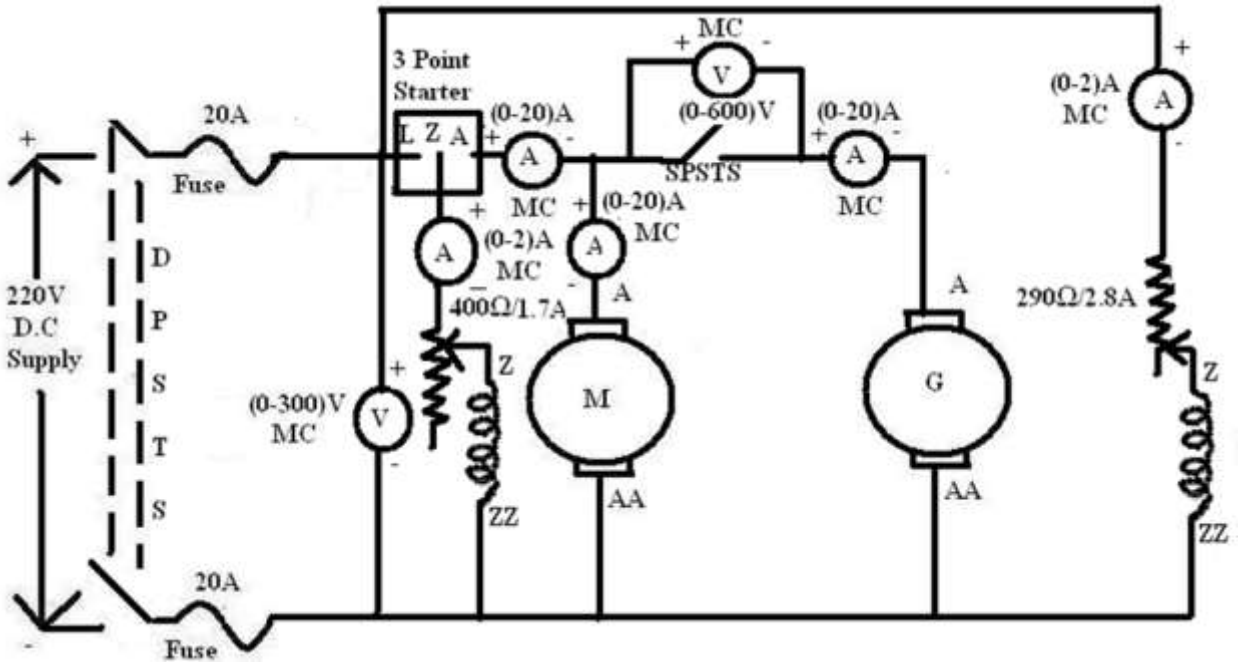


Result:

6. Hopkinson's tests on DC shunt machines

Aim: To conduct a regenerative test on two identical mechanically coupled D.C shunt machines to determine the efficiency of each machine

Circuit Diagram:



Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST Switch and switch ON 220V D.C supply.
3. Start the Motor Generator set with the help of starter.
4. Adjust the field rheostat of the motor and bring the Motor Generator set to its rated speed.
5. Adjust the field rheostat of the generator and bring the voltage across the SPST Switch to zero.
6. By using the field rheostat of the generator in steps note down all the meter readings till maximum rated current of any of the machine i.e., Motor or Generator.
7. Observing the precautions switch OFF the supply.

Formulas:

Generator:

Armature Copper Losses = $I_{ag}^2 Ra$

Stray Losses = Ws = VIL - ($I_{am}^2 Ra + I_{ag}^2 Ra$)

Output = $I_{ag} V$

Input = Output + Losses

Total Losses = + $I_{ag}^2 Ra + I_{fg} V_L$

Efficiency = ŋ % = (Output/Input) X 100

Motor

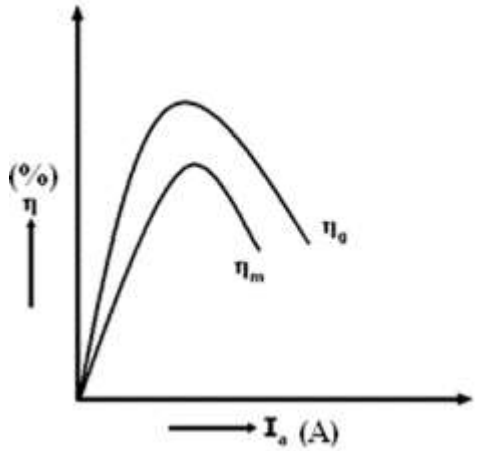
Total Losses = $+ I_{am}^2 Ra + I_{af}V$

Input = $V I_{am}$

Output = Input – Losses

Efficiency = ŋ % = (Output/Input) X 100

Model Graph



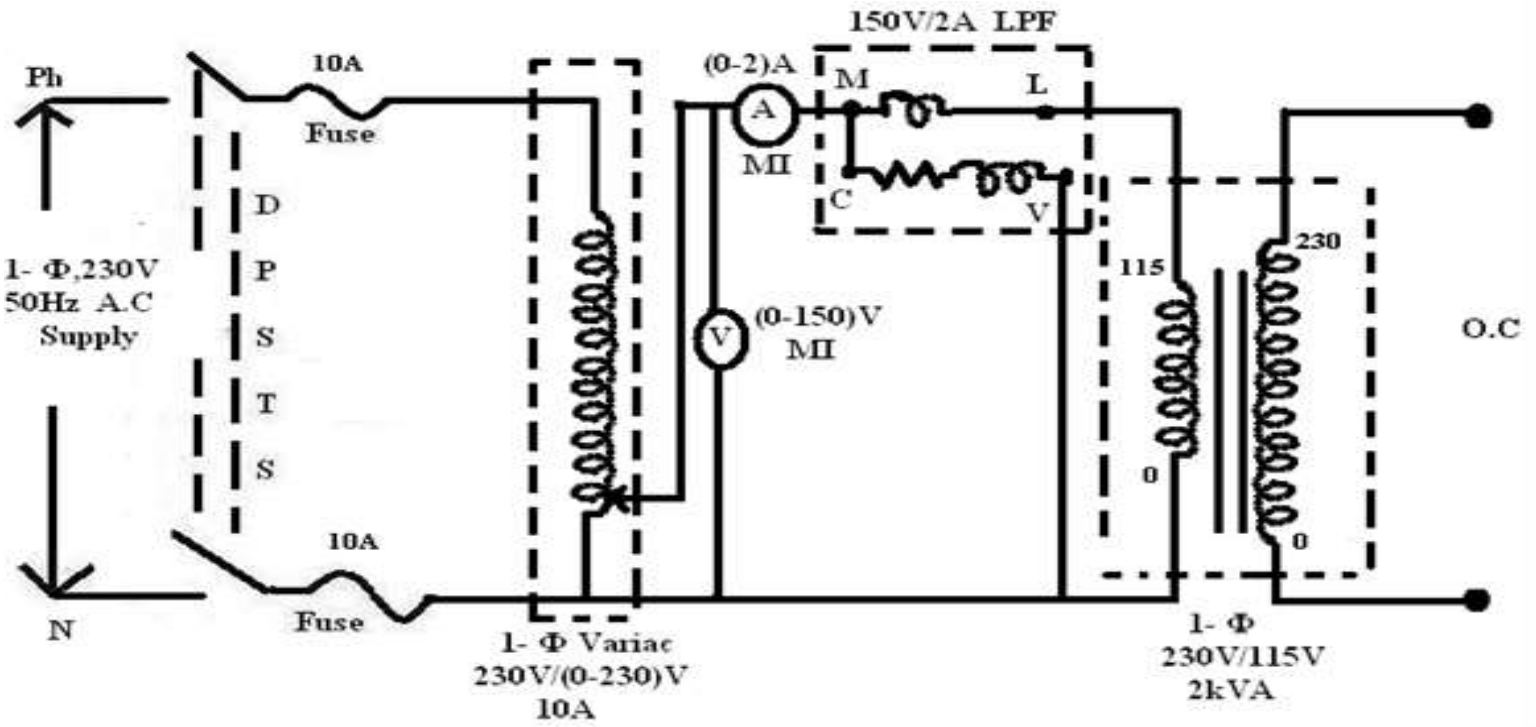
7. OC and SC test on single phase transformer

Aim:

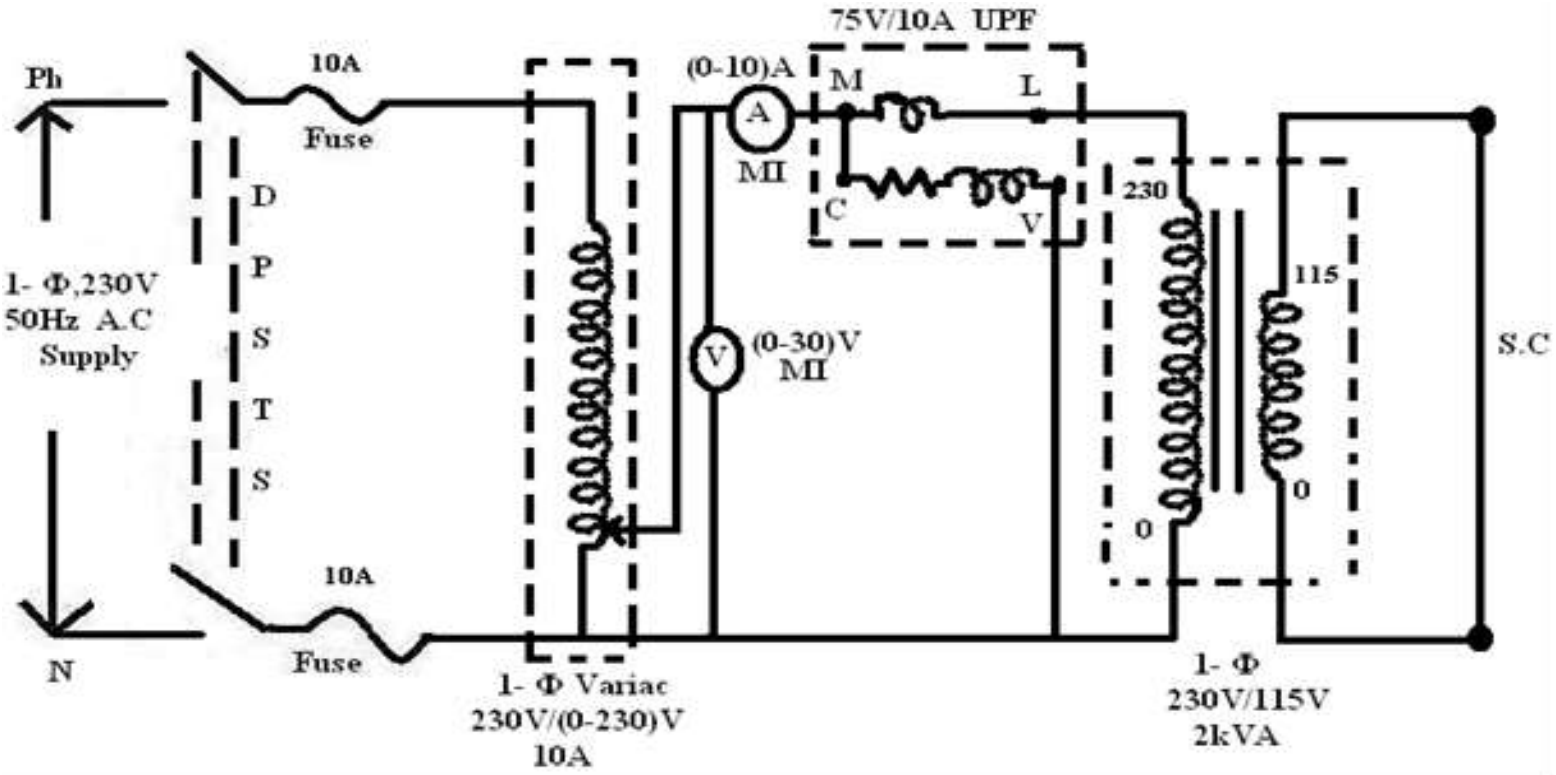
a)To determine the efficiency &regulation of 1- Ø transformer by conducting OC and S.C Test.
b)To draw the equivalent circuit of 1- Ø transformer referred to L.V side as well as H.V side.

Circuit Diagrams:

OC Test:



SC Test:


75V/10A UPF
Ph
10A
Fuse
(0-10)A
M
L
A
MI
D
P
S
T
S
C
V
230
115
S.C
1- Φ,230V
50Hz A.C
Supply
V
(0-30)V
MI
0
0
10A
N
Fuse
1- Φ Variac
230V/(0-230)V
10A
1- Φ
230V/115V
2kVA

Procedure:

1.Connect the circuit as shown in circuit diagram for O.C test.

2.Observing the precautions switch ON 1- Ø A.C supply and by using the 1-Φ variac apply the rated voltage of the primary of the transformer.

3.Note down all the meter readings. Here wattmeter reading gives iron loss.

4.Observing the precautions switch OFF the supply.

5.Connect the circuit as shown in circuit diagram for S.C test.

6.Observing the precautions switch ON 1- Ø A.C supply and by using the 1-Φ variac apply the rated current to the transformer. (Rated power of the transformer/Voltage of primary of transformer)

7.Note down all the meter readings, here wattmeter reading gives full-load copper loss.

8.Observing the precautions switch OFF the supply.

Result:

Model Calculations:

Let the transformer rating is 115/230 V (O.C Test)

Primary is L.V side and secondary is H.V side

$R_o = V_0 / Iw$ (Ω) where $I_w = I_o \cos\Phi_o$

$X_o = V_0 / I\mu$ (Ω) where $I\mu = I_o \sin\Phi_o$

$R_{o2} = W_{SC} / I_{SC}^2$ (Ω)

$Z_{O2} = V_{SC} / I_{SC}$

$Xo2 = \sqrt{(Z_{O2} - R_{o2})}$

where, K=V2/V1=Transformation Ratio

Calculations to find efficiency:

For example, at 1/4th full load,

Copper Losses=W_{SC} x $(1/4)^2$ (w),where, W_{SC}=Full Load Copper Losses

Constant Losses=W_o (W)

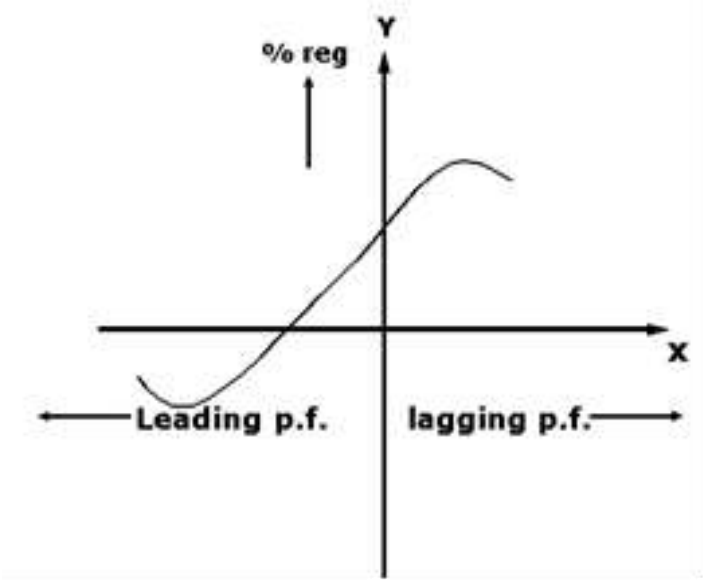
Output=(1/4) X VA X cosΦ (cosΦ may be assumed)

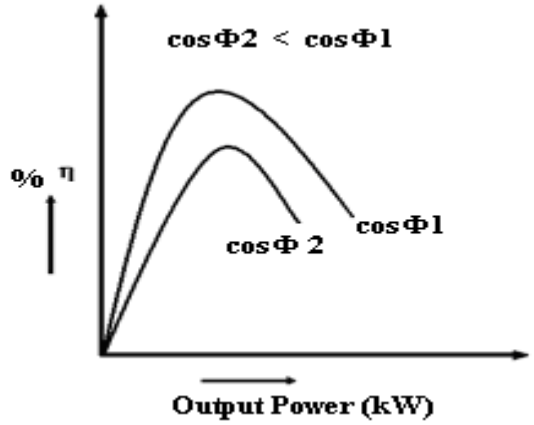
Input=Output + Copper Loss + Constant Loss

Efficiency (%η) = (Output/Input) X 100

Efficiency at different loads and power factor can be calculated.

Model Graphs:





Result:

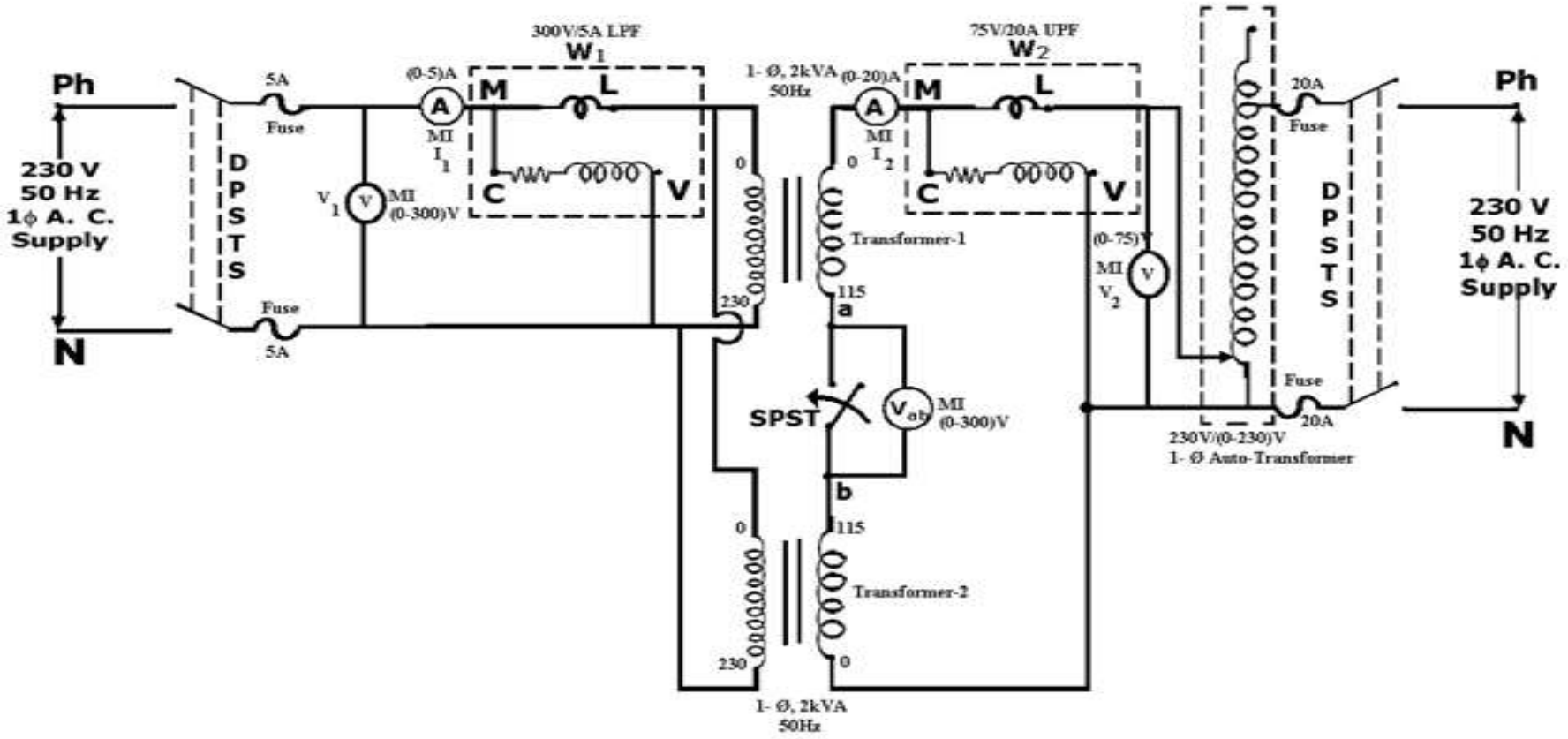
8. Sumpner's Test

Aim:

i.To conduct Sumpner's Test on two identical 1- Ø transformers.

ii.To find out the iron loss, copper loss and the efficiency of each transformer.

Circuit Diagram:



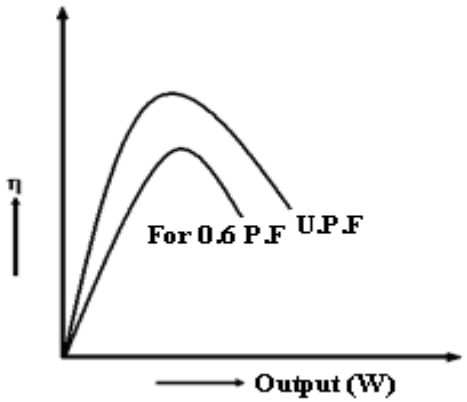
Formulae:

Losses in each transformer = $\frac{W_i + W_c}{2}$

(%) η combined = $\frac{VI_1}{VI_1 + W_i + W_c}$ X 100

Efficiency of each Transformer = η (%) = $\frac{VI_1}{VI_1 + \frac{W_i}{2} + \frac{W_c}{2}}$ X 100

Model Graphs:



Result:

9. Load Test on DC Compound Generator

(Both Cumulative & Differential)

Aim: To perform load test on D.C Compound Generator and plot its load characteristics

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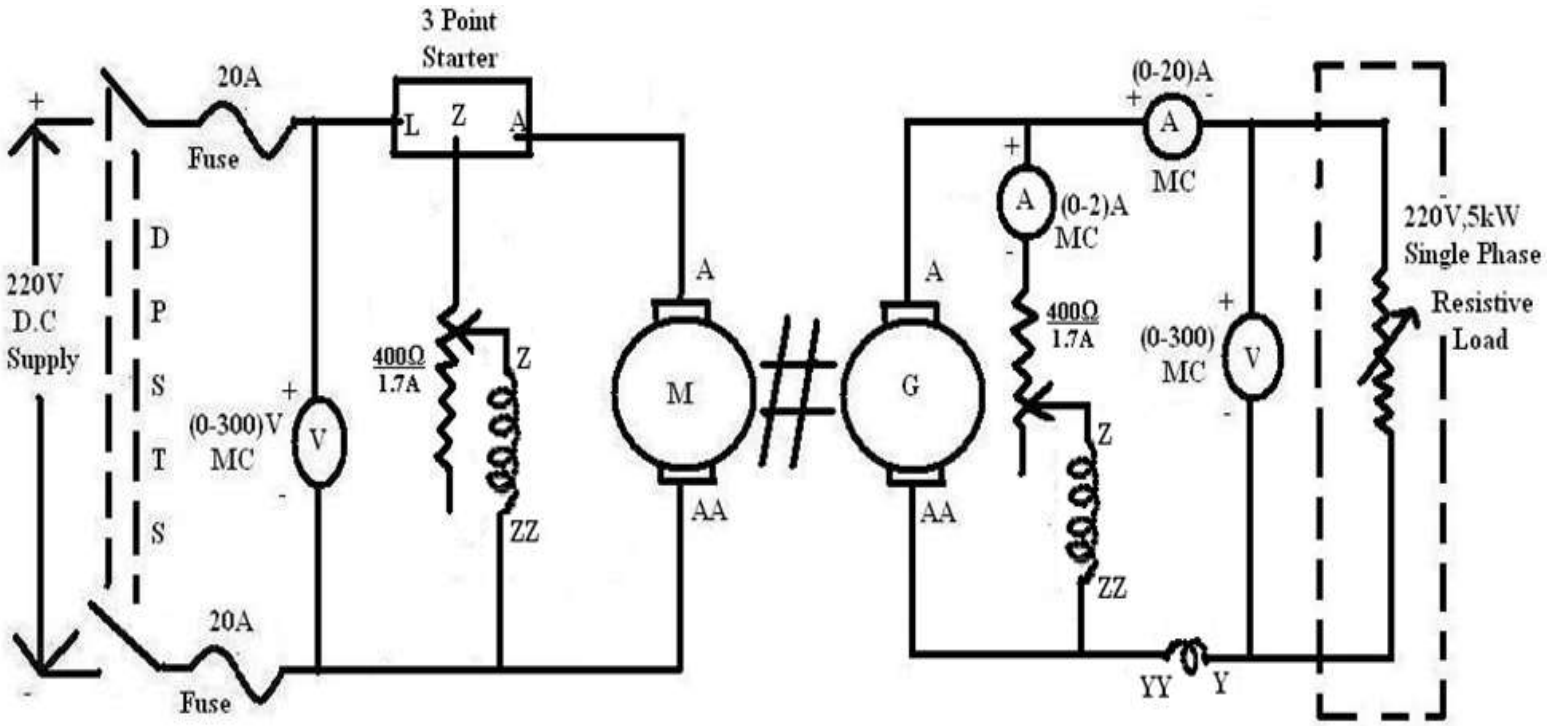
Circuit Diagram:



Tabular column:

Differential Compounding Generator					Cumulative Compounding Generator				
I_L (A)	I_f (A)	V_L (V)	I_a (A)	E_g (V)	I_L (A)	I_f (A)	V_L (V)	I_a (A)	E_g (V)

Formulae:

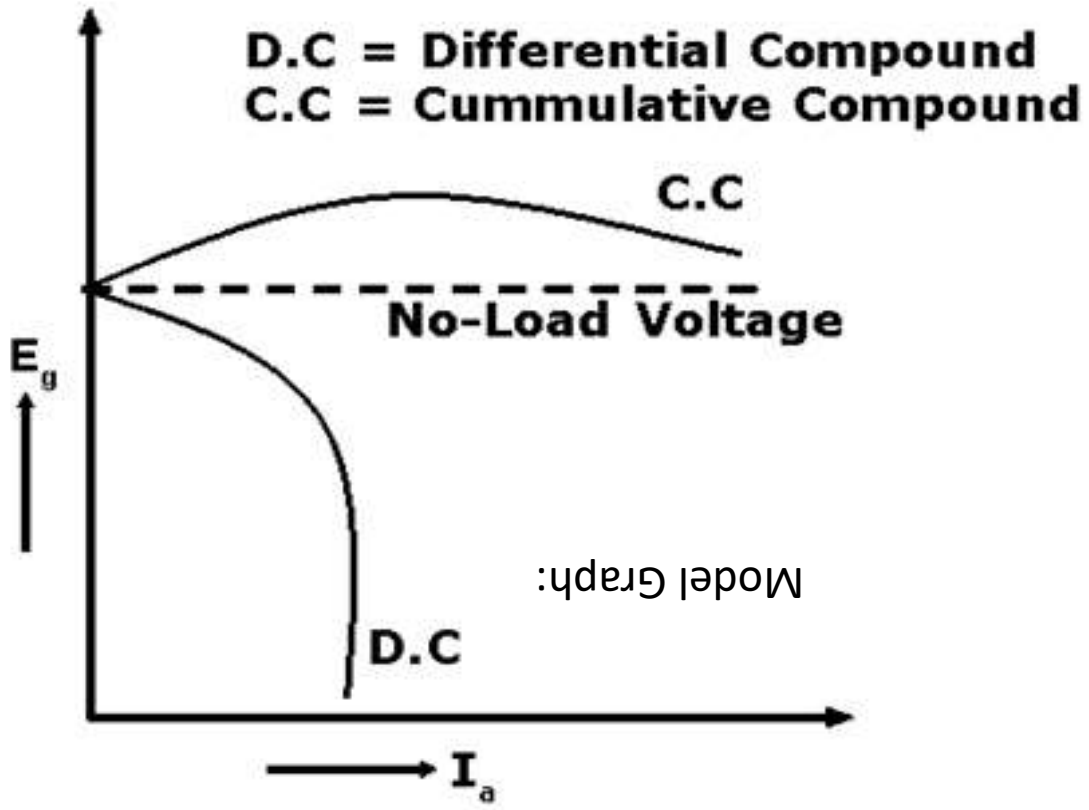
For Cumulative Compound: $I_L = I_a + I_f$

$E_g = V_L + I_L (R_a + R_{Se})$

For Differential Compound: $I_L = I_a - I_f$

$E_g = V + I_a (R_a + R_{Se})$

Model Graph:

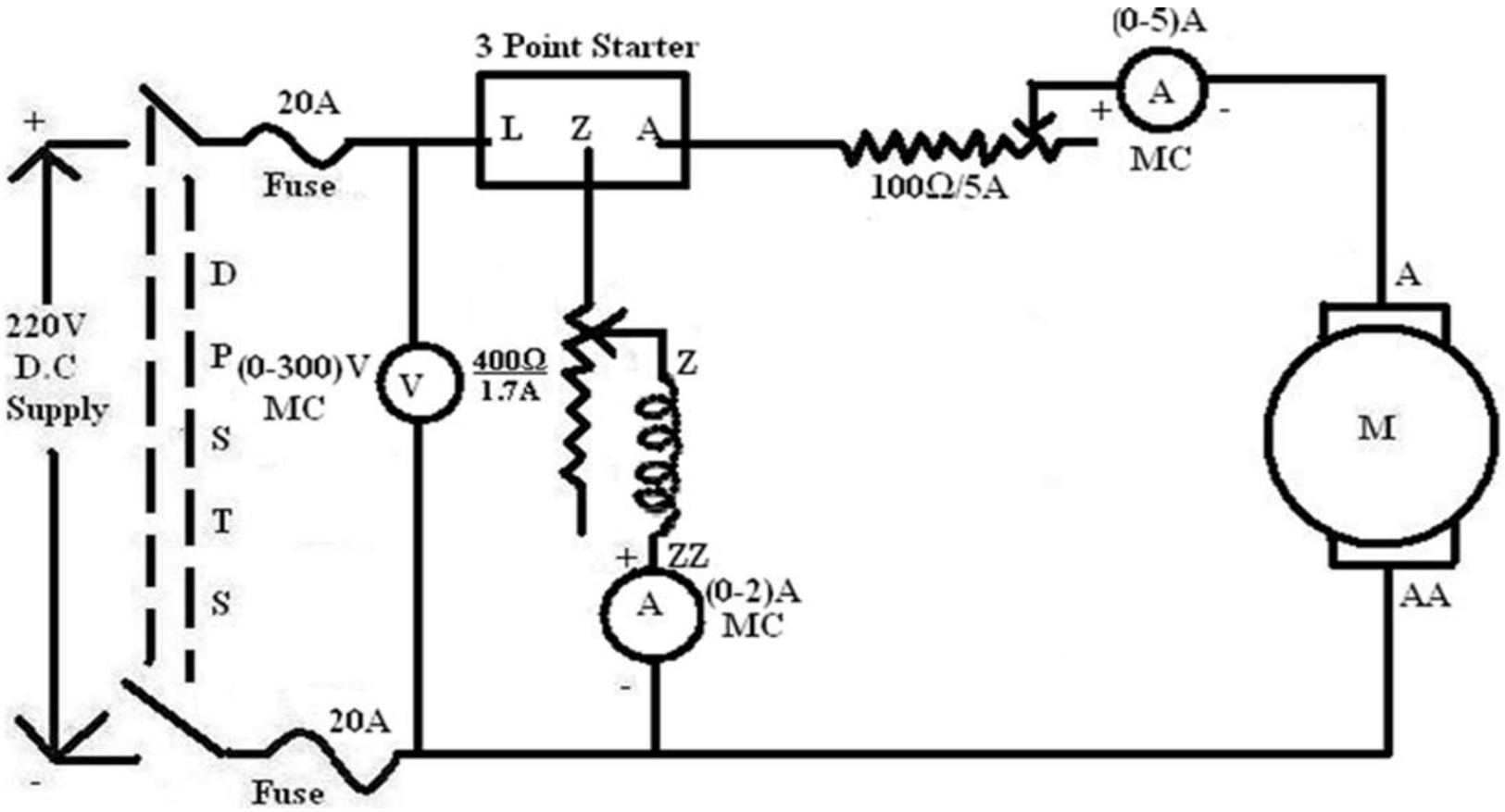


Model Graph:

10. Separation of Losses in a DC Shunt Motor

Aim: To separate hysteresis, eddy current and mechanical losses of a D.C Shunt Machine.

Circuit Diagram:



ELECTRICAL MACHINES LAB-I

Precautions:

1. Field rheostat must be kept in minimum resistance position.
2. Armature rheostat must be kept in maximum resistance position.

Procedure:

1. Connect the circuit as shown in circuit diagram.
2. Observing the precautions close the DPST switch and switch ON 220V D.C supply.
3. Start the motor by adjusting the armature rheostat and obtain the rated voltage across the terminals of the armature. Now adjust the field rheostat and bring the speed of motor to its rated value.
4. Now vary the armature rheostat in steps and for each step note down the speed and all the meter readings.
5. Repeat the procedure for another excitation (3/4 or ½ the rated value) suitably adjusting the field rheostat.
6. Observing the precautions switch OFF the supply.

To find Armature Resistance:

1. Connect the circuit as shown in circuit diagram.
2. Keeping the rheostat in its maximum resistance position close the DPST Switch and switch ON 220V D.C Supply.
3. By adjusting the rheostat for different values of current note down the meter readings.
4. Observing the precautions switch OFF the supply.

Tabular Columns:

Field Current=0.6A						Field Current=0.8A					
V_L (V)	I_a (A)	N (rpm)	$I_L = I_a + I_f$ (A)	W_c (W)	W_c/N (W/A)	V_L (V)	I_a (A)	N (rpm)	$I_L = I_a + I_f$ (A)	W_c (W)	W_c/N (W/A)

To find Losses:

Speed N (rpm)	Hysteresis Losses AN	Eddy Current Losses BN^2	Mechanical Losses $W_c - (W_h + W_e)$

To find Armature Resistance:

S. No.	V_a (V)	I_a (A)	R_a (Ω)
1			
2			
			Avg=

Formulae:

$W_C = V_L I_L - I_a^2 R_a$

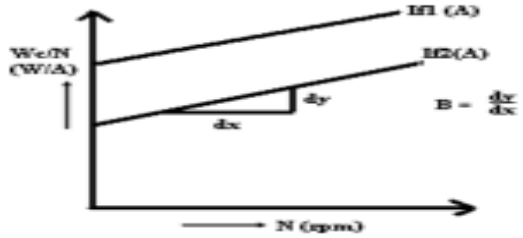
$W_i = W_h + W_e$

$W_h = AN$

$W_e = BN^2$

$W_{mech} = W_C - (W_h + W_e)$

Model Graphs:

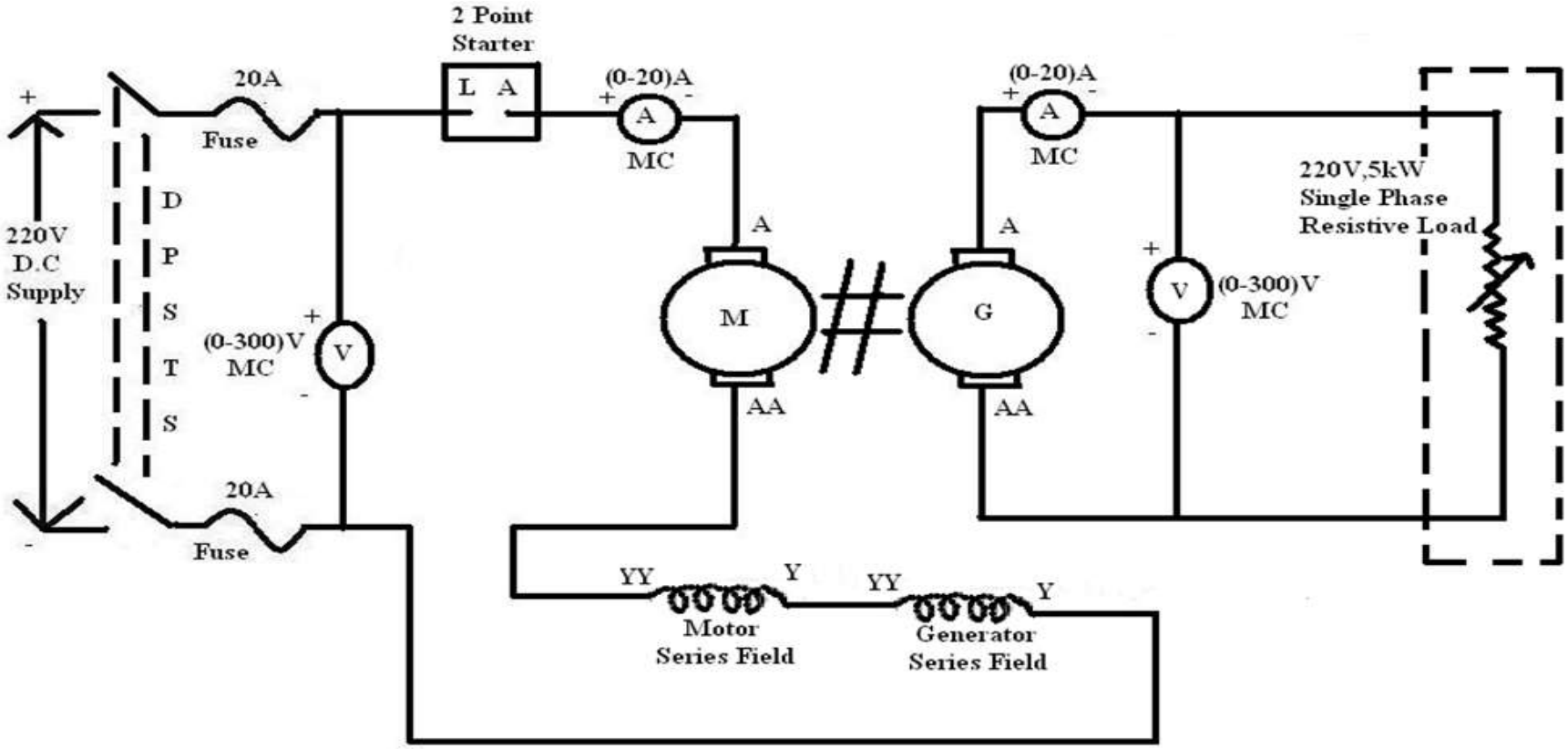


Result:

11. Field Test

Aim: To determine the performance characteristics of a D.C Series motor using Field Test

Circuit Diagram:



Tabular Column:

V_1 (V)	V_2 (V)	I_1 (A)	I_2 (A)	N (rpm)	Motor			Generator		
					Input (W)	Total Losses (W)	η (%)	Output (W)	Losses (W)	η (%)

Formulae:

Motor:

Motor Input = V_1I_1

Motor Losses = Armature + Field Losses + Stray Losses

$W_m = (R_a + R_{se})\, I_1^2 + W_s$

$\% \eta_m = (V_1I_1 - W_m) / (V_1I_1)$

Generator:

Generator Output = V_2I_2

Field Losses = $I_2^2R_{se}$

Armature Cu Losses = $I_2^2R_a$

Stray Losses = $W_s = \dfrac{W_1 - W_2}{2}$

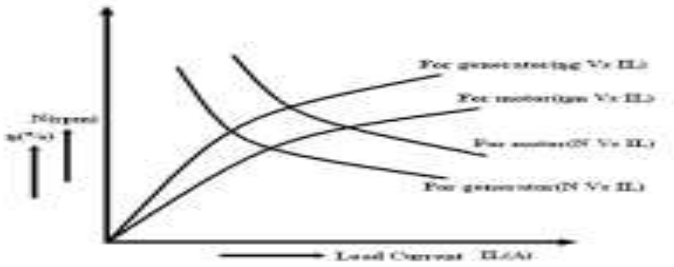
Total Losses = $I_1^2R_{se} + I_2^2R_a + W_s = W_g$

Total Losses = $W_t = V_1I_1 - V_2I_2$

$W_c = (R_a + 2\,R_{se})\, I_1^2 + I_2^2\, R_a$

$\% \eta_g = (V_2I_2) / (V_2I_2 + W_g)$

Model Graph:



12. Retardation Test

EXPERIMENT – 10

RETARDATION TEST

1. AIM:

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

2. NAME PLATE DETAILS:

MOTOR

Voltage	
Current	
Output	
Speed	

10.3 CIRCUIT DIAGRAM:

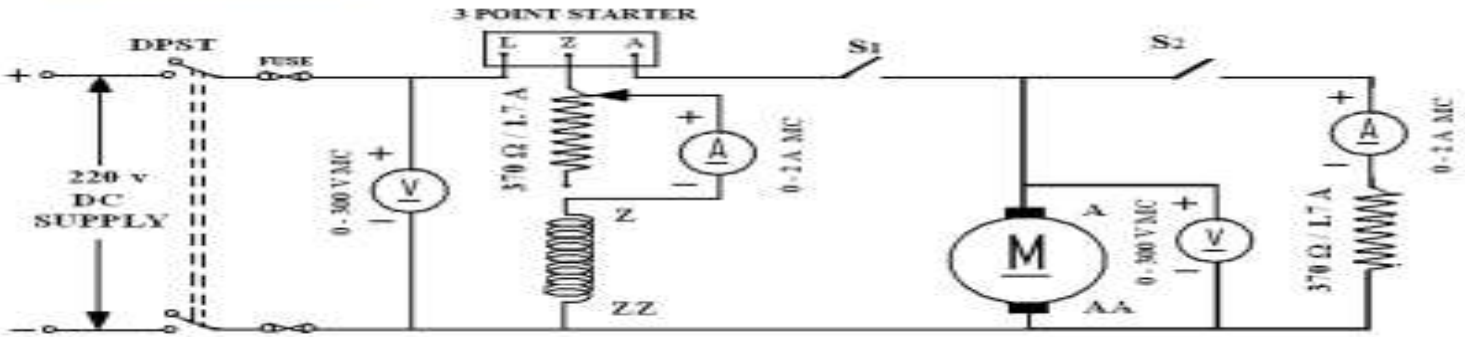


Fig – 10.1 DC Shunt Motor

10.4 APPARATUS:

S.No	Meter	Type	Range	Quantity
1	Ammeter			
2	Ammeter			
3	Voltmeter			
4	Rheostat			
5	Tachometer			

10.5 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 also 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.

10.6 TABULAR COLUMN:

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)

10.7 CALCULATIONS:

Rotational losses or stray losses $P_S = P \left[t / (t_2 - t_1) \right]$

$P_s = V_{avg} * I_{avg}$

Input power = $V I_L$

I_L - full load current of the motor

Armature cu losses = $I_a^2 R_a$

$I_a = I_L - I_f$

Total losses = Armature cu losses + Stray losses

Output power=Input -Total losses

Motor efficiency η = output/input.

GENERAL INSTRUCTIONS FOR LABORATORY CLASSES

DO‘S

1.Without Prior permission do not enter into the Laboratory.
2.While entering into the LAB students should wear their ID cards.
3.The Students should come with proper uniform.
4.Students should sign in the LOGIN REGISTER before entering into the laboratory.
5.Students should come with observation and record note book to the laboratory.
6.Students should maintain silence inside the laboratory.
7.Circuit connections must be checked by the lab-in charge before switching the supply

DONT‘S

8.Students bringing the bags inside the laboratory..
9.Students wearing slippers/shoes insides the laboratory.
10.Students scribbling on the desk and mishandling the chairs.
11.Students using mobile phones inside the laboratory.
12.Students making noise inside the laboratory.
13.Students mishandle the devices.
14.Students write anything on the devices

	
Fire Extinguishers	First Aid Box
	
Miniature Circuit Breaker's (MCB's).	CC Camera surveillance

Table 6.4.2 Safety Measures in the Laboratories

THANK YOU