ELECTRICAL AND ELECTRONICS ENGINEERING

LABORATORY MANUAL

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LIST OF EXPERIMENTS

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S. No.	Experiment Name	Date	Grade	Signature
1				
2				
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VERIFICATION OF KVL AND KCL

AIM:

To verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) in a Passive Resistive Network

APPARATUS REQUIRED:

S. No	Apparatus Name	Range	Type	Quantity
1.	RPS	(0 – 30V)	Digital	01
2.	Ammeter	(0 – 200mA)	Digital	03
3.	Voltmeter	(0 – 30V)	Digital	03
4.	Resistors	220 Ω, 150 Ω, 100 Ω	-	03
5.	Bread Board	-	-	01
6.	Connecting Wires	-	-	As required

CIRCUIT DIAGRAMS:

To Verify KVL:

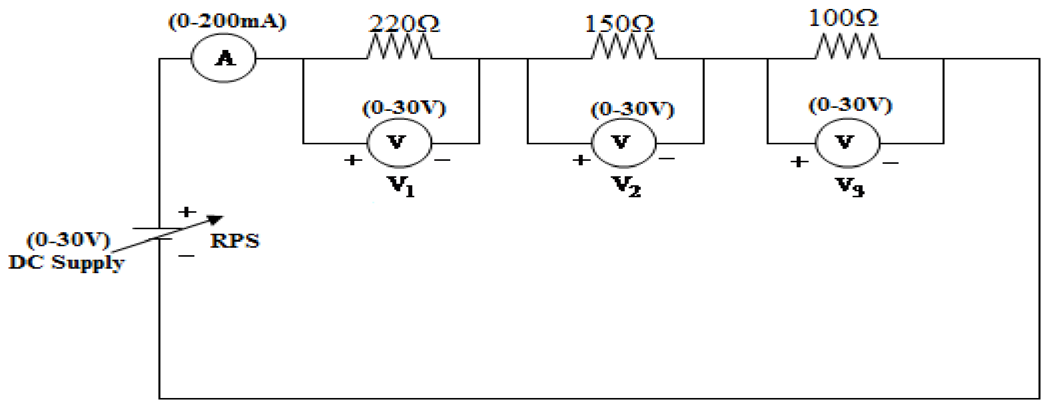


Figure 1

To Verify KCL:

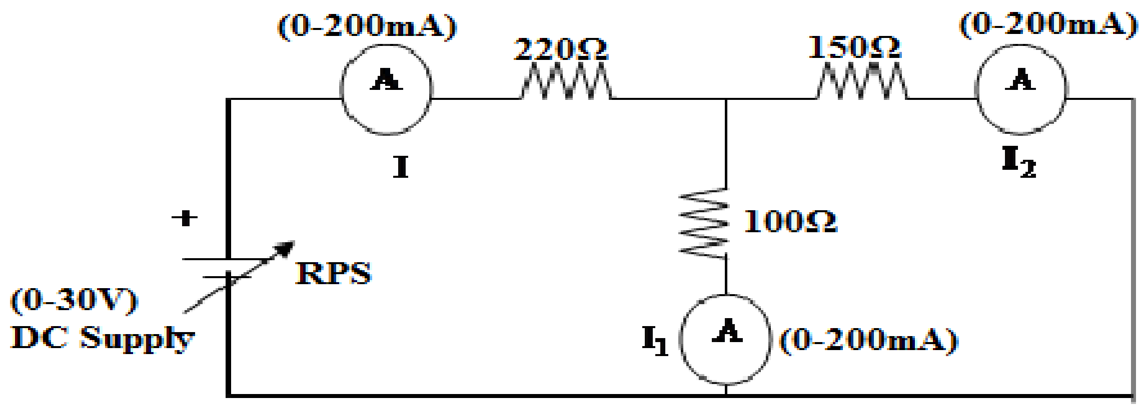


Figure 2

PROCEDURE:

To Verify KVL:

- Connect the circuit diagram as shown in Figure 1
- Switch ON the supply to RPS.
- Apply the voltage (say 5v) and note the voltmeter readings
- Gradually increase the supply voltage in steps
- Note the readings of voltmeters
- sum up the voltmeter readings (voltage drops) , that should be equal to applied voltage
- Thus KVL is Verified practically

To Verify KCL:

- Connect the circuit diagram as shown in Figure 2
- Switch ON the supply to RPS.
- Apply the voltage (say 5v) and note the Ammeter readings
- Gradually increase the supply voltage in steps
- Note the readings of Ammeters
- Sum up the Ammeter readings(I_1 and I_2) , that should be equal to total current(I)
- Thus KCL is Verified practically

OBSERVATIONS:

For KVL

Applied Voltage V (volts)	V_1 (volts)		V_2 (volts)		V_3 (volts)		$V_1+V_2+V_3$ (volts)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

For KCL

Applied Voltage V (volts)	I (A)		I_1 (A)		I_2 (A)		I_1+I_2 (A)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

PRECAUTIONS:

1. Check for proper connections before switching ON the supply
2. Make sure of proper color coding of resistors
3. The terminal of the resistance should be properly connected.

RESULT:

MAGNETIZATION CHARACTERISTICS OF A D.C. SHUNT GENERATOR

AIM:

To determine experimentally the Magnetization (or) Open Circuit Characteristics of a D.C. Shunt Generator and also to determine the critical field resistance.

APPARATUS REQUIRED:

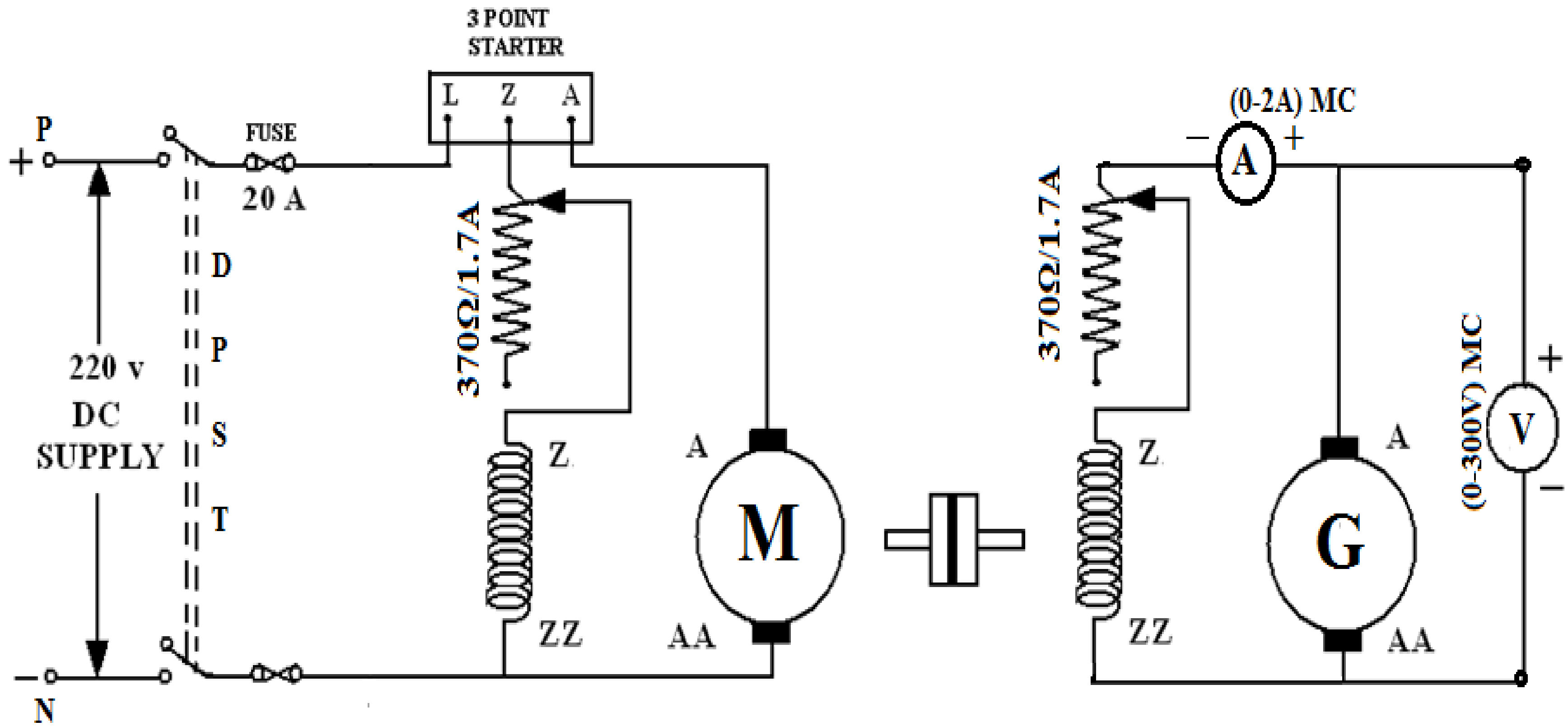
S. No.	Apparatus Name	Range	Type	Quantity
1	Ammeter	(0 – 2A)	MC	01
2	Voltmeter	(0 – 300V)	MC	01
3	Rheostat	370 ohms / 1.7 A	Wire wound	02
4	Tachometer	-	Digital	01
5	Connecting Wires	-	-	As required

NAME PLATE DETAILS:

MOTOR	
Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	

GENERATOR	
Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	

CIRCUIT DIAGRAM:



MAGNETIZATION CHARACTERISTICS (OR) OPEN CIRCUIT CHARACTERISTICS OF A D.C. SHUNT GENERATOR

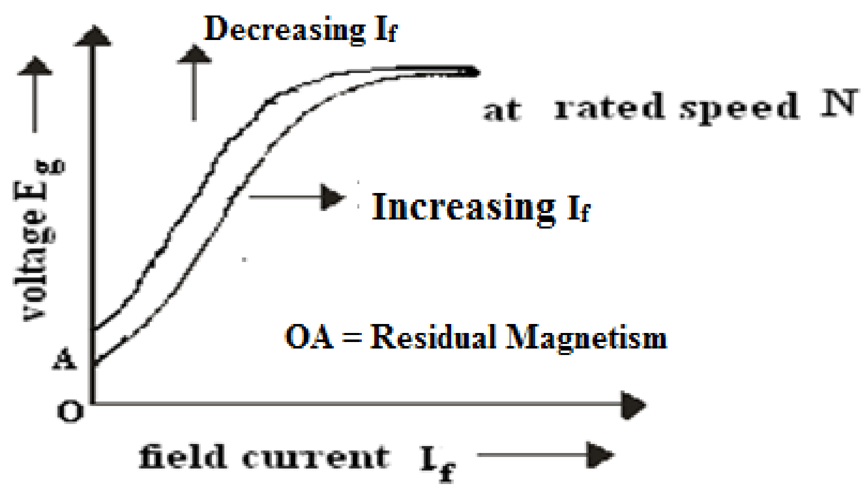
PROCEDURE:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.
2. Keep the field rheostat of motor and generator in minimum position.
3. Start the M-G Set and Observe the speed of the generator using a tachometer and adjust to the rated value by varying the motor field rheostat. Keep the same speed throughout the experiment.
4. Note down the terminal voltage of the generator. This is the E.M.F. due to residual magnetism.
5. Increase the generator field current I_f (ammeter) by gradually moving the jockey of generator field rheostat. For every value of I_f, note down the corresponding voltmeter reading. Increase the field current till induced E.M.F. is about 120% of rated value.
6. Repeat the same procedure for decreasing values of the same field currents (I_f) and finally note down the E.M.F. generated due to residual magnetism.
7. Draw the characteristics of generated E.M.F. (E_g) versus field current (I_f) for both increasing and decreasing values of field current.
8. Draw a tangent line to the initial portion of Characteristics from the origin. The slope of this straight line gives the critical field resistance.

OBSERVATIONS:

S. No.	ASCENDING		DESCENDING	
	Field Current I_f (amp)	Generated Voltage E_g (volts)	Field Current I_f (amp)	Generated Voltage E_g (volts)

MODEL GRAGH:



PRECAUTIONS:

1. The experiment should be done at constant speed.
2. The jockey should be moved only in one direction. It should not be moved back and forth for obtaining a particular field current.
3. At zero field there would be some emf due to residual magnetism
4. Avoid parallax errors and loose connections

RESULT:

VIVA Questions:

1. Under what conditions does the DC shunt generator fail to self-excite?
2. Define critical field resistance?
3. OCC is also known as magnetization characteristic, why?
4. How do you get the maximum voltage to which the generator builds up from OCC?
5. What does the flat portion of OCC indicate?
6. Why OCC does not start from origin?
7. Does the OCC change with speed?

SPEED CONTROL OF A D.C. SHUNT MOTOR

AIM:

To control the speed of a given D. C. Shunt Motor by armature control & field control methods.

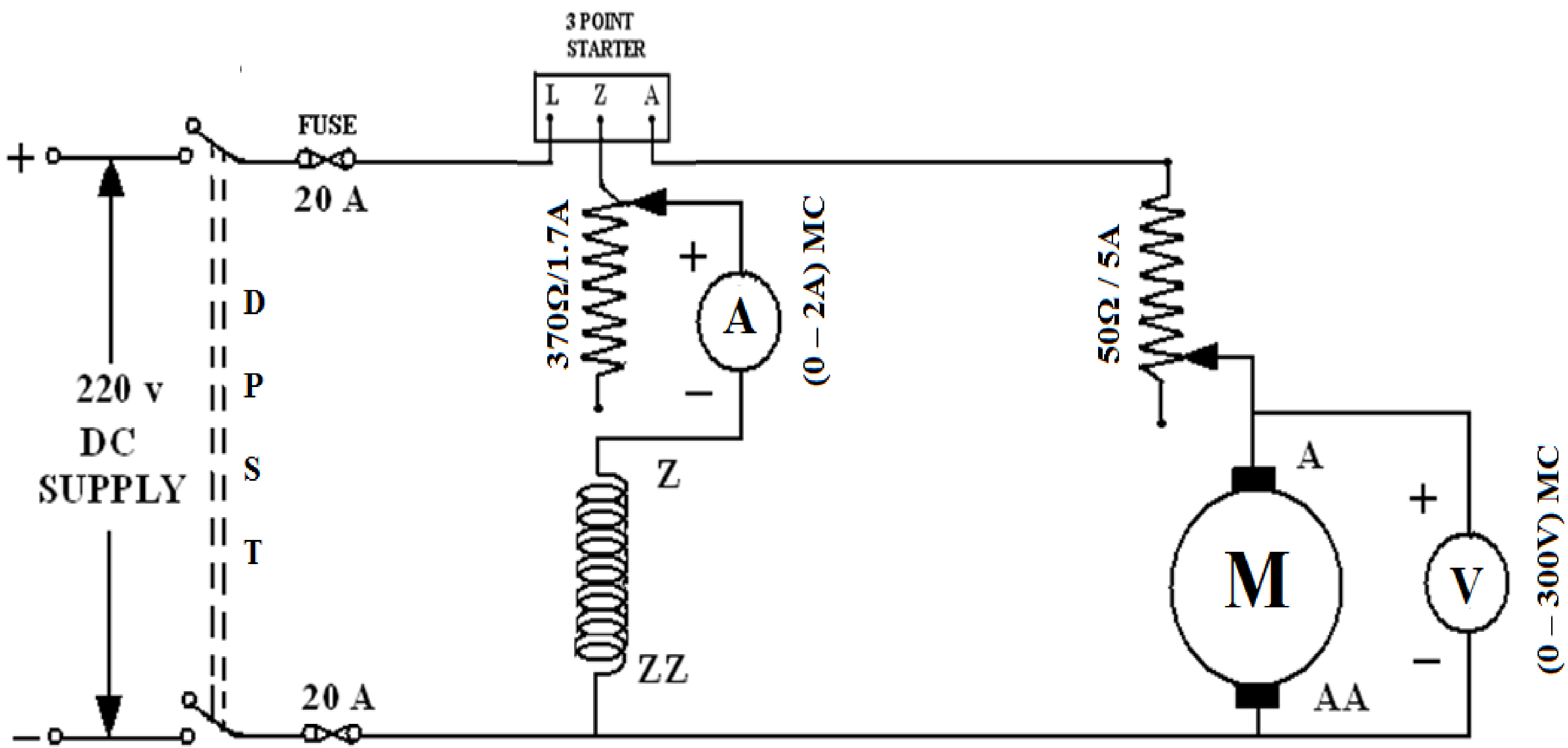
APPARATUS:

S. No.	Apparatus Name	Range	Type	Quantity
1	Ammeter	(0 – 2A)	MC	01
2	Voltmeter	(0 – 300V)	MC	01
3	Rheostat	370 Ω /1.7A	Wire wound	01
4	Rheostat	50 Ω /5A	Wire wound	01
5	Tachometer	-	Digital	01

NAME PLATE DETAILS:

MOTOR	
Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	

CIRCUIT DIAGRAM:



SPEED CONTROL OF A D.C. SHUNT MOTOR

PROCEDURE:

ARMATURE CONTROL METHOD:

1. Choose the proper ranges of meters after noting the name plate details of the given machine and make the connections as per the circuit diagram.
2. Keep the motor field rheostat in the minimum position and the armature rheostat in the maximum position.
3. Give supply and accelerate the motor by cutting out the armature circuit resistance until rated voltage is applied to the armature
4. Adjust the field rheostat to make the motor run at its rated speed when rated voltage is applied to the armature.
5. Keeping normal excitation, vary the armature voltage by varying the armature resistance and note down the speed of the motor for different voltages. Note down the field current also.
6. Tabulate these readings and plot the graph between Armature Voltage and Speed.

FIELD CONTROL METHOD:

1. Apply rated voltage to the armature by varying the armature rheostat.
2. Now vary the field current by varying the field rheostat and note down the speeds at different values of field current. *Take care that the speed doesn't exceed 2000 rpm.* Note down the armature voltage also.
3. Tabulate these readings and plot the graph between Speed and Field Current.

OBSERVATIONS:

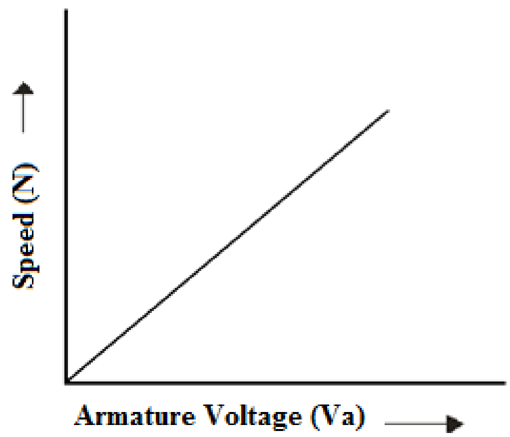
ARMATURE CONTROL METHOD:

S. No.	Armature Voltage Va (Volts)	Speed N (RPM)

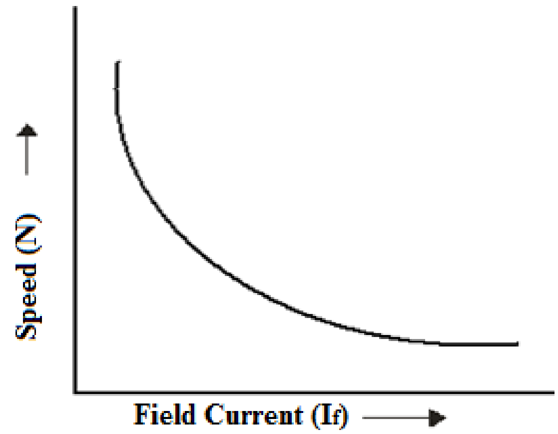
FIELD CONTROL METHOD:

S. No.	Field Current I_f (A)	Speed N (RPM)

MODEL GRAPH:



Armature Control



Field Control Method

RESULT:

Viva Questions:

Explain why the graph of armature speed control of motor is linear?

1. What is the shape of the curve of field control of method motor speed? Explain why is it so?
2. What is the disadvantage of using armature control of speed on load?
3. How do you change the direction of rotation of a D.C. motor?
4. What are the limitations of shunt field control?
5. Comment on the efficiency calculated by this method.
6. Why do you need a starter in a dc motor?

BRAKE TEST ON DC SHUNT MOTOR

AIM:

To obtain the performance characteristics of DC shunt motor by direct loading.

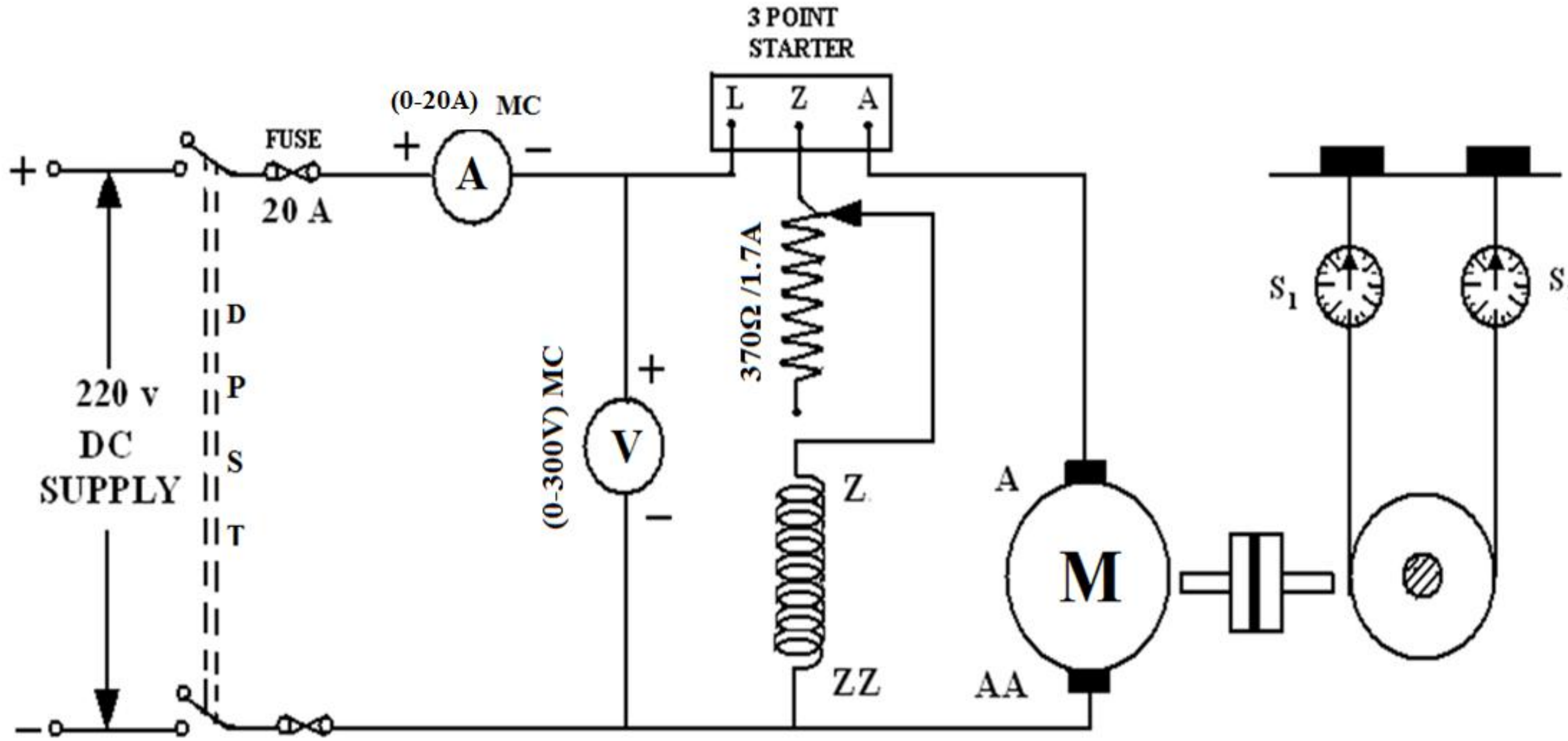
APPARATUS REQUIRED:

S. No.	Name of the Equipment	Range	Type	Quantity
1.	Voltmeter	(0 – 300V)	MC	01
2.	Ammeter	(0 – 20A)	MC	01
3.	Rheostat	370Ω /1.7A	Wire wound	01
4.	Tachometer	-	Digital	01
5.	Connecting wires	-	-	As required

NAME PLATE DETAILS:

MOTOR	
Voltage (V)	
Current (A)	
Output (KW/HP)	
Speed (RPM)	

CIRCUIT DIAGRAM:



BRAKE TEST ON D.C. SHUNT MOTOR

PROCEDURE:

1. Make the connections as shown in the circuit diagram.
2. Keeping the field rheostat at the minimum position, switch on the supply and start the motor.
3. Adjust the speed of the motor on no load to its rated value by means of the field rheostat. DO NOT DISTRUB THE POSITION OF THE RHEOSTAT THROUGH OUT THE TEST.
4. Put on the load by tightening the screws of the spring balances. Note down the spring tensions, the speed, the voltage and the currents at different loads until full load current obtained.

MODEL CALCULATIONS:

1. Measure the circumference of the brake drum and calculate its radius (R), in meters.
2. Calculate the torque, $T = W*R*g$ (N-m).

Where $W = W_1 \sim W_2$ = spring balance reading (the difference between the spring tensions) and 'g' is acceleration due to gravity i.e.9.81.

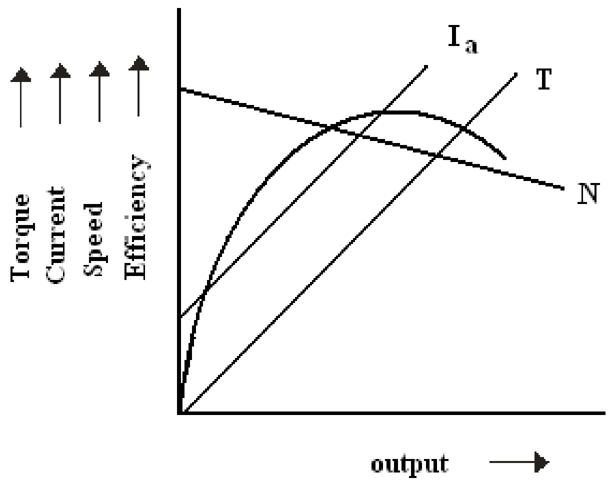
3. Calculate the power output of the motor given by $P_0 = 2\Pi NT/60$
4. Calculate the input power, $P_I = V*I_L$(I_L is the line current = $I_a + I_f$).
5. Calculate the percentage efficiency, $\eta = P_0/P_I * 100$

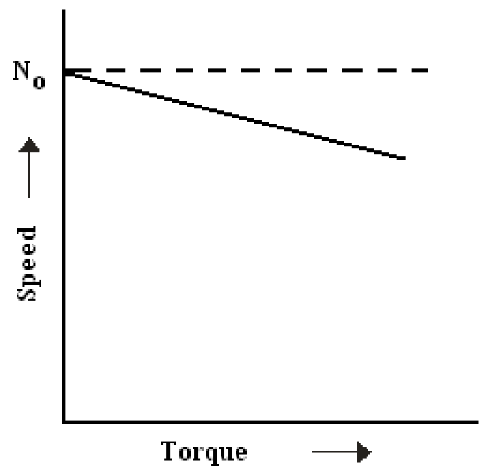
OBSERVATIONS:

Radius of Brake Drum: R = 0.15m

S. No.	Voltage V (volts)	Current I (amp)	Speed N (r.p.m.)	Spring Balance readings (Kgs)			Torque $T = 9.81 \cdot R \cdot (S_1 \sim S_2)$ (N-m)	Input $P_{in} = V \cdot I$ (Watts)	Output $P_o = \frac{2\pi NT}{60}$ (Watts)	η P_{in} / P_o (%)
				S_1	S_2	$S_1 \sim S_2$				

MODEL GRAPHS:





RESULT:

VIVA Questions:

1. Why did you use a 3-point starter for starting a D.C shunt motor?
2. If starter is not available, how can you start a D.C motor?
3. What is the efficiency range of a D.C motor?
4. Where can you use the D.C shunt motor?
5. Why is it considered as a constant speed motor?

OPEN CIRCUIT & SHORT CIRCUIT TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To perform Open Circuit and Short Circuit tests on a single phase transformer and to pre-determine the efficiency, regulation and equivalent circuit of the transformer.

APPARATUS REQUIRED:

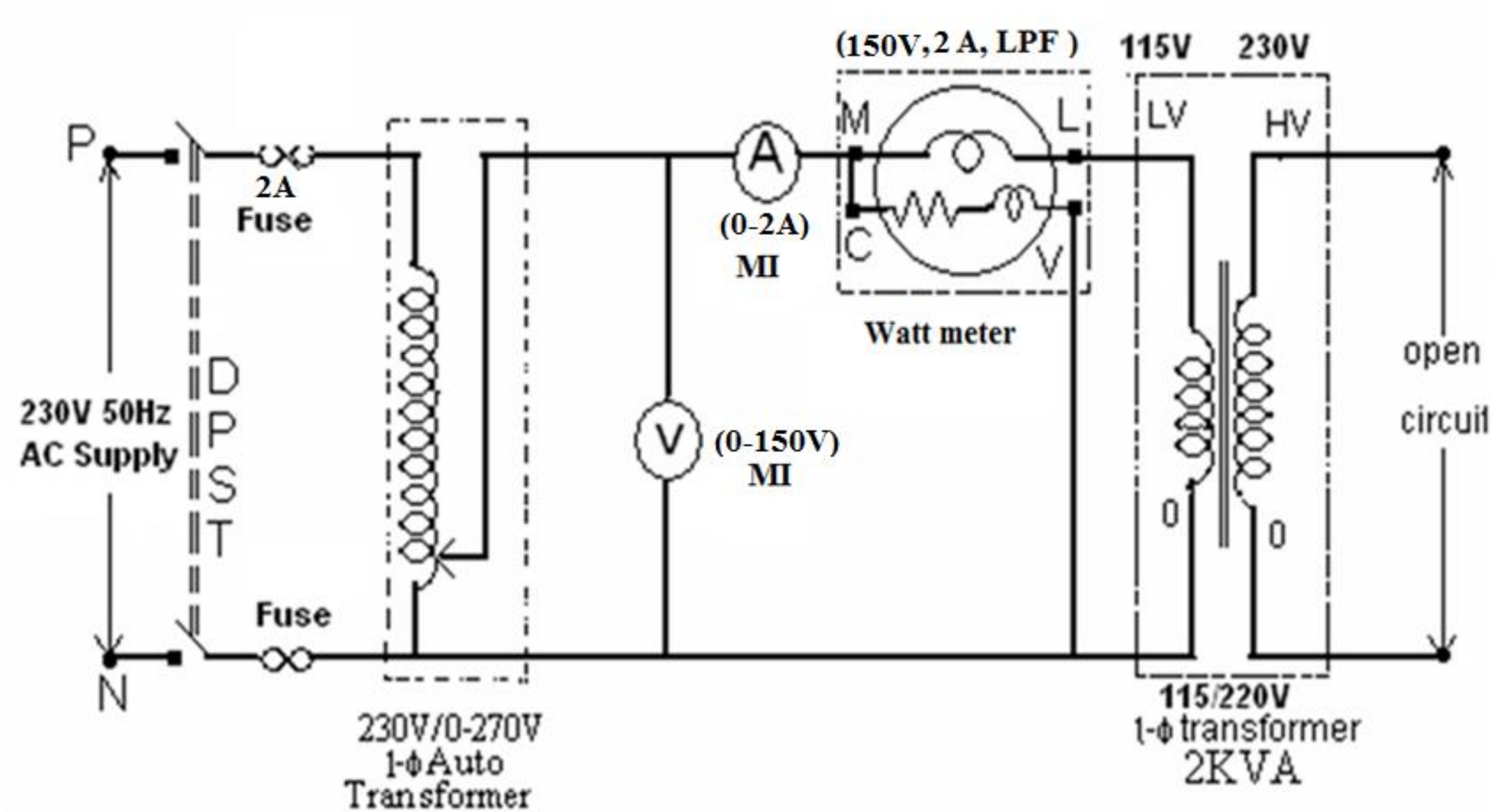
S. No.	Apparatus Name	Range	Type	Quantity
2	Voltmeter	(0 – 150V)	MI	01
3	Ammeter	(0 – 2A)	MI	01
4	Ammeter	(0 – 10A)	MI	01
3	Wattmeter	(150V, 2A, LPF)	Dynamo meter type	01
4	Wattmeter	(150V, 10A, UPF)	Dynamo meter type	01
5	Connecting Wires	-	-	As required

NAME PLATE DETAILS:

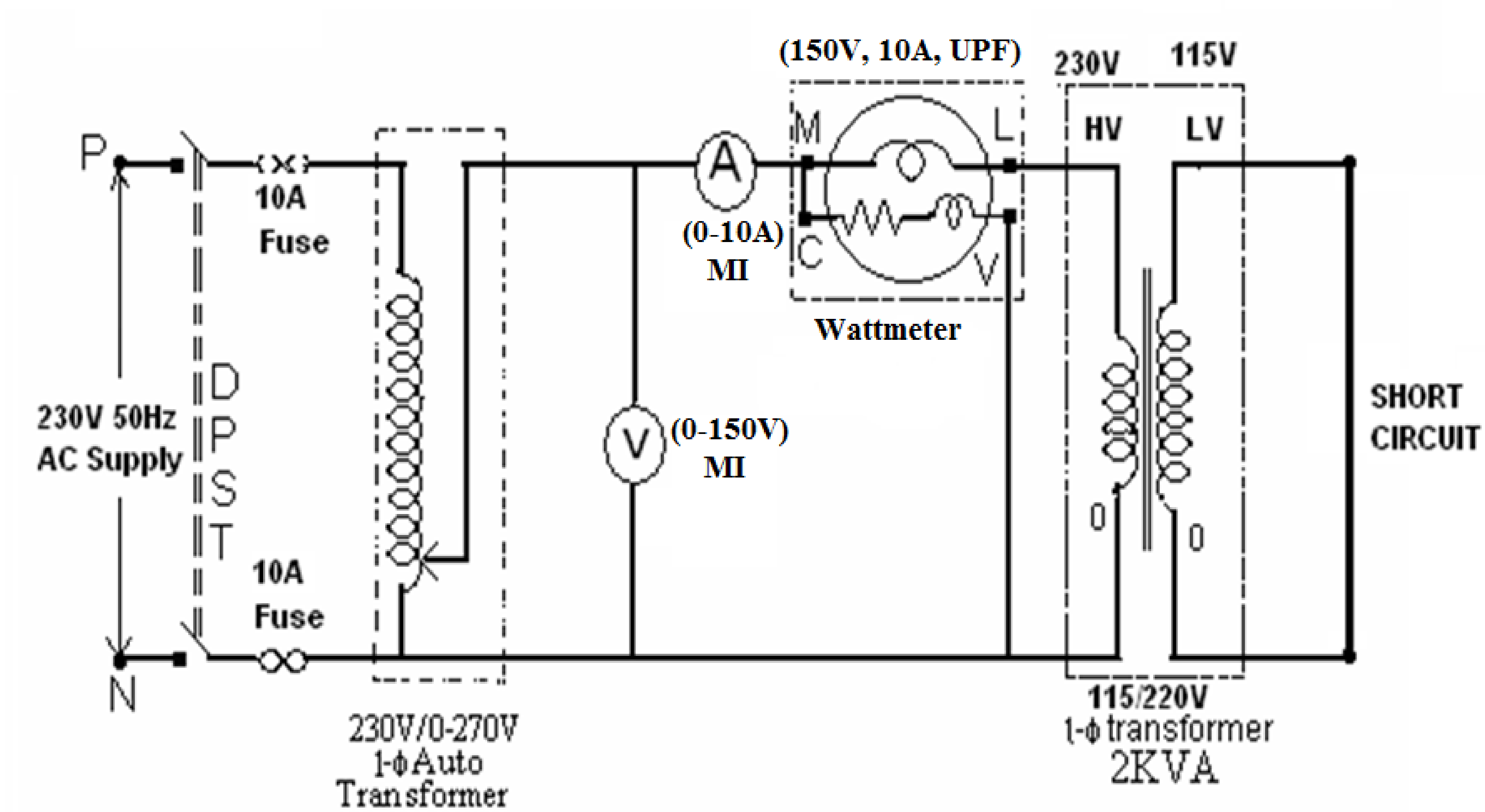
Transformer Specifications		**Autotransformer Specifications**	
Capacity (KVA)		Capacity (KVA)	
Primary Voltage (V)		Input Voltage (V)	
Secondary Voltage (V)		Output Voltage (V)	
Phase		Phase	
Frequency (Hz)		Frequency (Hz)	

CIRCUIT DIAGRAMS:

OPEN CIRCUIT TEST:



SHORT CIRCUIT TEST:



PROCEDURE:

OPEN CIRCUIT TEST:

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

SHORT CIRCUIT TEST:

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

OBSERVATIONS:

Open Circuit Test:

Voltage (Rated) (V_o)	Current (I_o)	Power (W_o)

Short Circuit Test:

Voltage (V_{SC})	Current (Rated) (I_{SC})	Power (W_{SC})

MODEL CALCULATIONS:

Find the equivalent circuit parameters R_0, X_0, R_{1e}, R_{2e}, X_{1e} and X_{2e} from the O. C. and S. C. test results and draw the equivalent circuit referred to primary side.

Let the transformer be the step-up transformer, then

Primary is L. V. side.

Secondary is H. V. side

From OC test:

$$\cos \emptyset_o = \frac{W_o}{V_o * I_o}$$

Working component of current $I_c = I_o * \cos \phi_0$

Magnetizing component of current $I_m = I_o * \sin \phi_0$

$R_0 = \frac{V_1}{I_w}$ Where $I_c = I_0 \cos\phi_0$

$$X_0 = \frac{V_1}{I_m} \quad \text{Where } I_m = I_0 \sin \phi_0$$

From SC Test:

$$R_{2e} = \frac{W_{SC}}{I_{SC}^2}$$

$$Z_{2e} = \frac{V_{SC}}{I_{SC}} = \sqrt{R_{2e}^2 + X_{2e}^2}$$

$$\therefore \qquad X_{2e} = \sqrt{Z_{2e}^2 - R_{2e}^2}$$

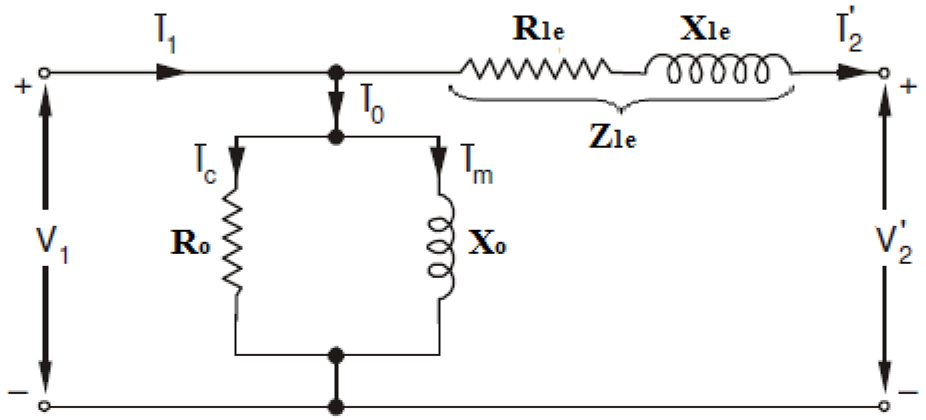
Thus we will get the equivalent circuit parameters referred to secondary side of the transformer. The primary side parameters are calculated by using the transformation ratio K.

$$R_{1e} = R_{2e}/K^2$$

$$X_{1e} = X_{2e}/K^2$$

Where $K = \frac{V_2}{V_1} =$ Transformation ratio.

Then draw the equivalent circuit of transformer referred to primary as below



Calculations to find efficiency and regulation from OC and SC tests

The efficiency and Regulation can be Predetermined at any load (n) and any power factor using the formulas given below

$$\% \eta \text{ at any load} = \frac{n*(VA)*\cos\emptyset}{n*(VA)*\cos\emptyset + W_o + n^2 * W_{sc}}$$

Where n = Fraction of full load

n = 1 (at full load)

n = ½ (at half load)

n = ¼ (at quarter load)

$$\% \text{ Re}\,gulation\ (\%R) = \frac{I_1 R_{1e} \cos\phi \pm I_1 X_{1e} \sin\phi}{V_1}\ x\,100$$

or

$$\% \text{ Re}\,gulation\ (\%R) = \frac{I_2 R_{2e} \cos\phi \pm I_2 X_{2e} \sin\phi}{V_2}\ x\,100$$

Where V_1 is the rated Voltage and

I_1 ,I_2 are rated currents for full load.

For any other load the currents I_1, I_2 must be changed by fraction n.

I_1=n*I_{1rated} and I_2=n*I_{2rated}

'+' for lagging power factors

'-' for leading power factor

Cosϕ = 1.0

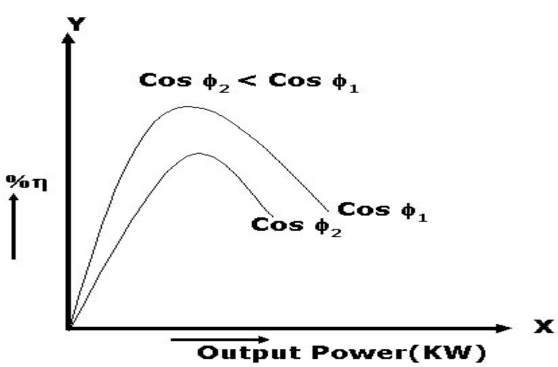
Load n	Pcu (W) $= n^2 * Wsc$	P_i (W) = Wo	O/P (W) = n* (VA)*Cosϕ	I/P (W) = O/P + Pcu + Pi	η (%)	%R

Cosϕ = 0.8

Load n	Pcu (W) $= n^2 * Wsc$	P_i (W) = Wo	O/P (W) = n* (VA)*Cosϕ	I/P (W) = O/P + Pcu + Pi	η (%)	%R

GRAPHS:

% Efficiency Vs output



PRECAUTIONS:

(i) Connections must be made tight

(ii) Before making or breaking the circuit, supply must be switched off

RESULT:

BRAKE TEST ON 3- ϕ SQUIRREL CAGE INDUCTION MOTOR

AIM:

To determine the efficiency of 3- ϕ induction motor by performing load test and to obtain the performance curves for the same.

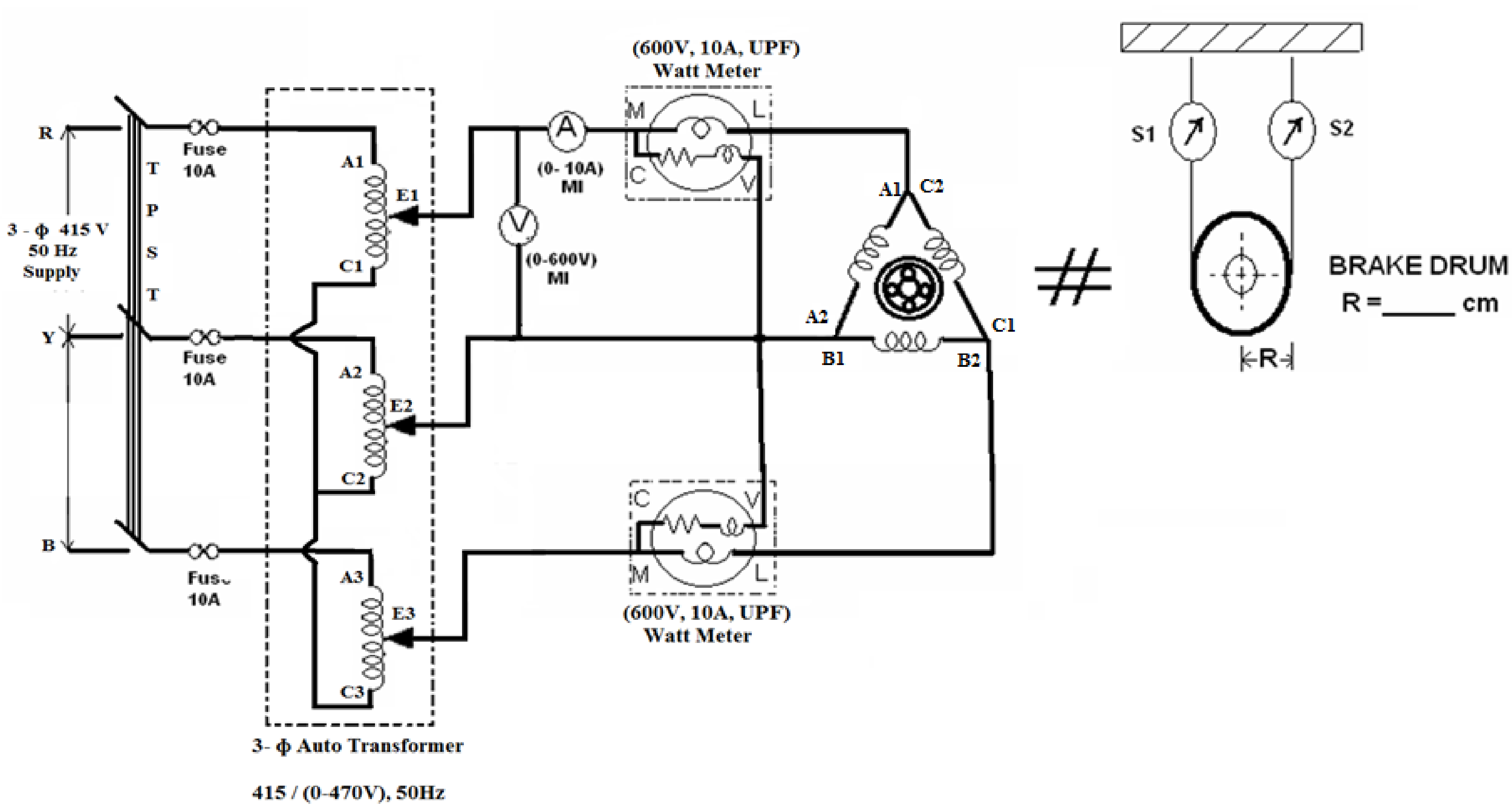
APPARATUS REQUIRED:

S. No.	Equipment	Range	Type	Quantity
1	Voltmeter	(0 – 600V)	MI	01
2	Ammeter	(0 – 10A)	MI	01
3	Wattmeter	(600V, 10A, UPF)	Dynamo meter type	02
4	Tachometer	-	Digital	01
5	Connecting Wires	-	-	As required

NAME PLATE DETAILS:

3- ϕ Squirrel Cage Induction Motor		**3- ϕ Auto Transformer**	
Voltage (V)		Capacity (KVA)	
Current (A)		Input Voltage (V)	
Power (KW/HP)		Output Voltage (V)	
Speed (RPM)		Phase	
Frequency (Hz)		Frequency (Hz)	

CIRCUIT DIAGRAM:



BRAKE TEST ON THREE – PHASE SQUIRREL CAGE INDUCTION MOTOR

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. Ensure that the 3- ϕ variac is kept at minimum output voltage position and belt is freely suspended.
3. Switch ON the supply, Increase the variac output voltage gradually until rated voltage is observed in voltmeter. Note that the induction motor takes large current initially, so keep an eye on the ammeter such that the starting current should exceed the rated current.
4. By the time speed gains rated value, note down the readings of voltmeter, ammeter, and wattmeter at no-load.
5. Now the increase the mechanical load by tightening the belt around the brake drum gradually in steps.
6. Note down the various meters readings at different values of load till the ammeter shows the rated current.
7. Reduce the load on the motor and also bring the variac to minimum position, then switch OFF the supply.

MODEL CALCULATIONS:

Input power drawn by the motor W = ($W_1 + W_2$) watts

Shaft Torque, $T_{sh} = 9.81 * R * (S_1 \sim S_2)$ N-m → Radius of drum in meters.

Output power $P_o = \frac{2\pi N T_{sh}}{60}$ *watts*

$$\%\ Efficiency = \frac{Output\ Power\ in\ watts}{Input\ Power\ in\ watts}\ x\ 100$$

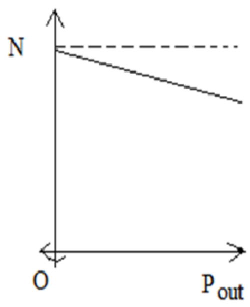
$$\%\ slip = \frac{N_s - N}{N_s}\ x\ 100 \qquad \left[where\ N_s = \frac{120\ x\ f}{p}\right]$$

Power factor of the induction motor $\cos\phi = \frac{W}{\sqrt{3}\ V\ I}$

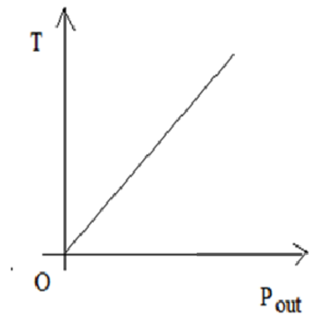
OBSERVATIONS:

S. No.	V (volts)	I (amps)	Power W (Watts)		Speed (RPM)	Spring balance (Kg)			Torque T (N-m)	%Slip	Cos Ø	Input Power $P_i = W1+W2$ (Watts)	Output Power $P_o = \frac{2\pi NT}{60}$ (Watts)	%η
			W_1	W_2		S_1	S_2	$S_1 \sim S_2$						

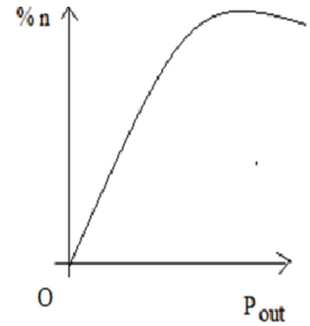
MODEL GRAPHS:



Speed vs Output Power



Torque vs Output Power



Efficiency vs Output Power

PRECAUTIONS:

1. Connections must be made tight.
2. Parallax errors must be avoided while taking the readings.
3. Pour the water in the brake drum for cooling purpose.

RESULT:

VIVA Questions:

1. Why starter is used? What are different types of starters?
2. Compare a slip ring induction motor with cage induction motor?
3. Why the starting torque is zero for a Single Phase induction motor and non-zero of 3phase induction motor?
4. What are the disadvantages of this method?
5. Can we use rotor resistance method for starting?