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Department of Mechatronics Engineering

BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY MANUAL

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VISION AND MISSION OF THE INSTITUTION

VISION
To become a world-class institution for engineering education by imparting quality education that meets global standards, cultivating students who are academically excellent, possess a positive attitude, are ethically sound and socially committed.
MISSION
❖ To enhance academic excellence by educating students in engineering principles, thereby upgrading their knowledge and skills
❖ To empower students with a positive attitude and creative thinking to develop innovative techniques in engineering
❖ To educate and cultivate dedicated learners with ethical values who are socially responsible

VISION AND MISSION OF MECHATRONICS ENGINEERING DEPARTMENT

VISION
To achieve excellence in Mechatronics Engineering through quality education and industry collaboration by integrating mechanical, electronics, computer, and control systems, thereby developing professionally competent, innovative, and socially responsible engineers to contribute in the field of automation, robotics, and smart manufacturing..
MISSION
❖ To strengthen a learner-centric and industry-integrated environment by imparting technical knowledge and practical skills in Mechatronics Engineering, including automation, robotics, IoT, and intelligent systems
❖ To equip learners with industry-relevant tools, problem-solving abilities, and innovative thinking to address real-world engineering challenges across interdisciplinary domains
❖ To nurture learners with professional ethics, leadership qualities, communication skills, and entrepreneurial skills ensuring lifelong learning and adaptability to evolving industrial demands.

BE3272 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY

L T P C

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OBJECTIVES:

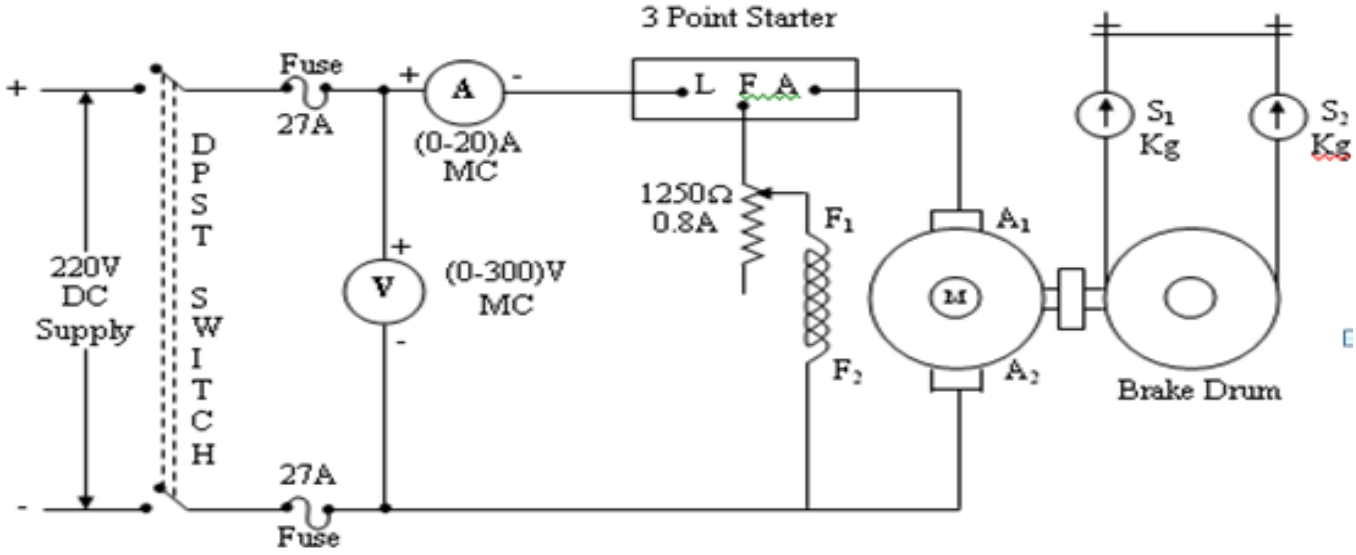
- To train the students in conducting load tests electrical machines.
- To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers.
- To train the students to measure three phase power and displacement.

LIST OF EXPERIMENTS:

1. Verification of ohms and Kirchhoff's Laws.
2. Three Phase Power Measurement
3. Load test on DC Shunt Motor.
4. Load test on Self Excited DC Generator
5. Load test on Single phase Transformer
6. Load Test on Induction Motor
7. Characteristics of PN and Zener Diodes
8. Characteristics of BJT, SCR and MOSFET
9. Design and analysis of Half wave and Full Wave rectifiers
10. Measurement of displacement of LVDT

TOTAL: 60 PERIODS

CIRCUIT DIAGRAM FOR LOAD TEST ON DC SHUNT MOTOR:



Name Plate details **Circumference =**

$2\pi r$ =_____cm

Rated Voltage : 220v

Rated current : 20A

Rated Speed : 1500RPM

EXPERIMENT NO 1

LOAD TEST ON DC SHUNT MOTOR

AIM:

To conduct a direct load test on the given dc shunt motor and to plot the following performance characteristics: 1) Efficiency vs Output power (2) Torque vs Output power (3) Speed vs Output Power (4) Line current vs Output Power (5) Torque vs Speed.

APPARATUS REQUIRED:

S. No.	Apparatus	Range & Type	Quantity
1	DC Shunt Motor Set up	-	1 No
2	Voltmeter	(0-300 V), MC	1 No
3	Ammeter	(0-2 A), MC (0-20 A), MC	1 each
4	Rheostat	220 Ω, 1 A	1No
5	Tachometer, DPSTS	-	1each
6	Connecting wires & Fuse	-	As Required

PRECAUTIONS:

1. Remove the fuse carriers before wiring and start wiring as per the circuit diagram.
2. Check the position of the rheostat as specified in the procedure.
3. The load on motor must be released initially.
4. Fuse calculations: As this is a load test, the required fuse ratings are 120% of the rated current of the motor.
5. Replace the fuse carriers with appropriate fuse wires after the circuit connections are checked by the Staff-in-charge.

PROCEDURE:

1. The circuit connections are made as per the circuit diagram.
2. Keeping the motor field rheostat in its minimum position and the starter in its OFF position the main supply is switched ON by closing the DPSTS.
3. The motor is started using the three-point starter by slowly and carefully moving the starter handle from its OFF to ON position.

4. The motor is brought to its rated speed by gradually adjusting the field rheostat and checked with the help of a tachometer.

TABULAR COLUMN:

S.No.	Voltage V (Volts)	Current I (Amps)	Spring Balance Reading		(S1-S2) Kg	Speed N (rpm)	Torque T (Nm)	Output Power Pm (Watts)	Input Power Pi (Watts)	Efficiency %
			S1 (Kg)	S2 (Kg)						
1.										
2.										
3.										
4.										
5.										
6.										

MODEL CALCULATION:

5.Under this no load condition, one set of readings namely, applied voltage (VL), armature current (Ia), field current (If), the two spring balance readings (F1and F2) and motor speed (N) are noted down in the tabular column.

5. The load on the motor is increased in steps gradually and at each step, all the meter readings and the motor speed are recorded in the tabular column. The above procedure is repeated until the motor is loaded to 120% of its rated current.
6. After the experiment is completed, the load on motor is gradually decreased to minimum and the rheostat is brought back to its original position and then the main supply is switched OFF.
7. After completing the experiment, calculate the Torque, Armature current, Input power, Output power and Efficiency using the formulae given.
8. The plots of Efficiency vs Output Power, Torque vs Output Power, Line Current vs Output Power and Speed vs Output Power are plotted in the same graph sheet and also the Speed vs Torque response is plotted in a separate graph sheet.

FORMULAE:

$$R = \frac{\text{Circumference}}{100 \times 2\pi} \text{ m}$$

Torque T = $(S_1 - S_2) \times R \times 9.81$ Nm

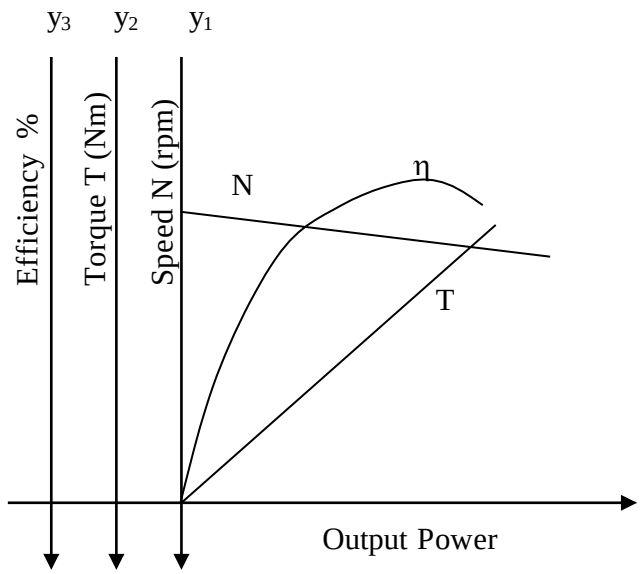
Input Power P_i = VI Watts

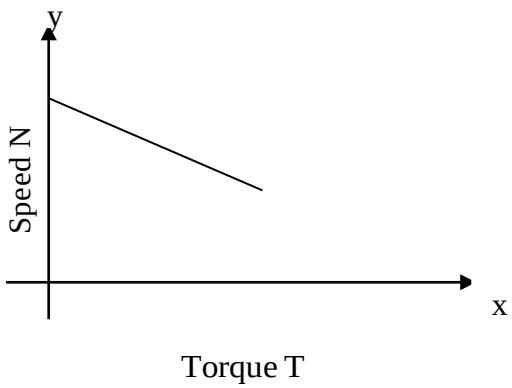
$$\textbf{Output Power } P_m = \frac{2\pi NT}{60} \text{ Watts}$$

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

Input Power

MODEL GRAPHS:

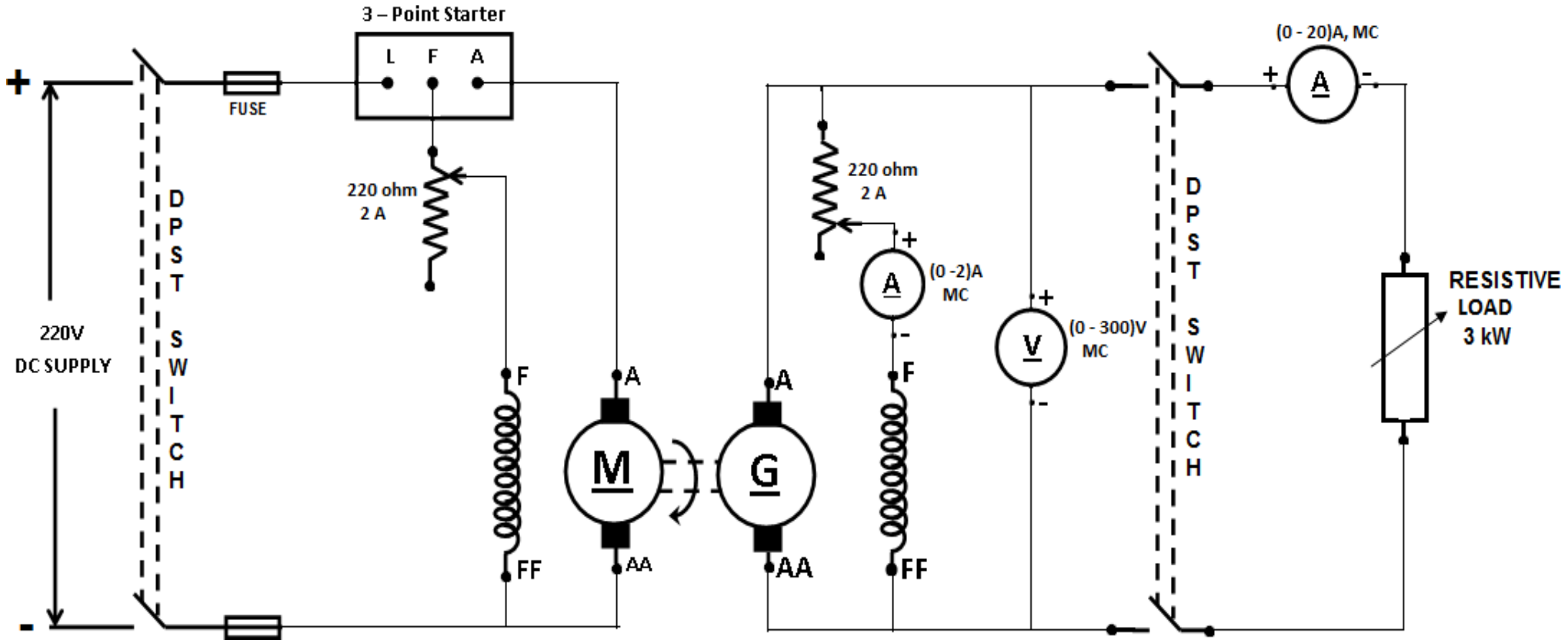




RESULT:

Thus load test on DC shunt motor is conducted and its efficiency is determined.

OPEN CIRCUIT & LOAD TEST



Name Plate details

Rated Voltage : 220v

Rated current : 20A

Rated Speed : 1500RPM

Circumference = $2\pi r$ =_____cm

EXPERIMENT NO 2

OPEN CIRCUIT AND LOAD CHARACTERISTICS OF SELF EXCITED DC SHUNT GENERATOR

AIM:

To obtain open circuit characteristics and load characteristics of a self excited DC shunt generator and find its critical resistance

APPARATUS REQUIRED

S. No.	Apparatus	Range & Type	Quantity
1	DC Shunt Generator Set up	-	1 No
2	Voltmeter	(0-300 V), MC	1 No
3	Ammeter	(0-2 A), MC (0-20) A MC	1 each
4	Rheostats	200 Ω/3 A 400 Ω/3 A	1 each
5	SPST & DPST switch	-	1 No
6	Tachometer	-	1 No
7	Connecting wires & Fuse	-	As Required

THEORY

A DC generator requires an excitation circuit to generate an induce voltage depending on whether excitation circuit consumes power for the armature of the machine or from separately require power supply. Generators may be classified as self excited or separately excited generators respectively.

The induced emf in DC generators is given by the equation PϕZN/60A volts. State P,Z,A are constants the above equation are written as Eg= KϕN. I f the speed of the generator also maintained constant then Eg =Kϕ but the flux is directly proportional to the current Hence Eg

$=K^2I_f$.From the above equation it is clear that the induced emf is directly propositional to the field current. when speed maintained constant,. The plot between the induced emf and the field current is known as open circuit characteristics of the DC generator.

The induced emf when the field current is zero is known as residual voltage. This emf is due to the presence of a small amount of flux detained. In the field poles of the generator called residual flux.

Once the OCC is obtained parameters such as critical field resistance, critical speed and the maximum voltage to which the machine can build up can be **TABULATION**

Armature Resistance - Ra:_____ohm

OPEN CIRCUIT TEST

S. No.	Field Current If (A)	Armature Voltage Eo (V)
1		
2		
3		
4		
5		

LOAD TEST

S. No.	Field Current If (A)	Load Current IL (A)	Terminal Voltage (V)	Ia = IL + If (A)	Eg =V + Ia Ra (V)
1					
2					
3					
4					
5					
6					

MODEL CALCULATION

determined. If required the OCC at a different speeds can also be obtained. .Critical speed is minimum speed below which the generator shunt fails to excite.

FORMULAE:

$E_g = V + I_a R_a$ (V)

$I_a = I_L + I_f$ (A) [for self Excited]

where

E_g : Generated EMFin V

V : Terminal Voltage in V

I_a : Armature Current in A

I_L : LineCurrent in A

I_f : Field Current in A

R_a : Armature Resistance in Ohm

OPEN CIRCUIT TEST

PRECAUTIONS:

At the time of starting and stopping the machine,

1. The field rheostat of motor should be in minimum resistance position.
2. The field rheostat of generator should be in maximum resistance position.
3. No load should be connected to generator

PROCEDURE:

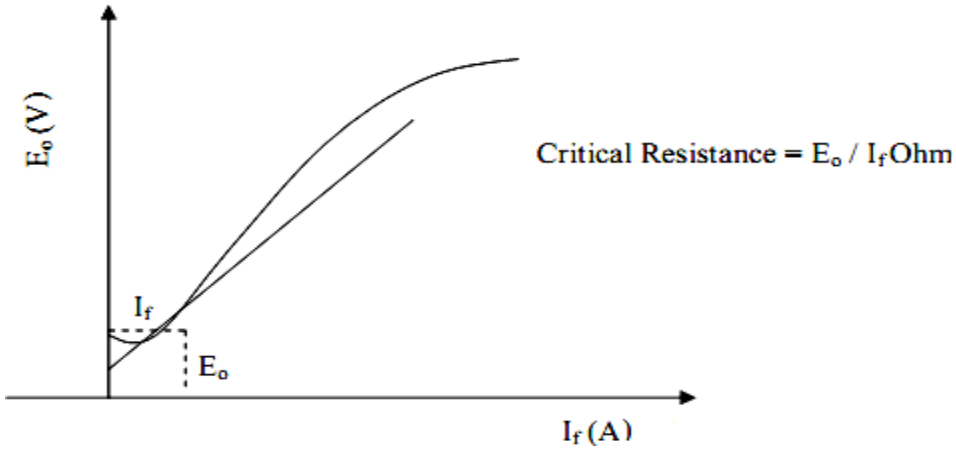
1. Connections are made as per the circuit diagram.
2. After checking minimum position of motor field rheostat, maximum position of generator field rheostat, DPST switch is closed and starting resistance is gradually removed.
3. By adjusting the motor field rheostat, the motor is brought to rated speed.

4. By varying the generator field rheostat, voltmeter and ammeter readings are taken.

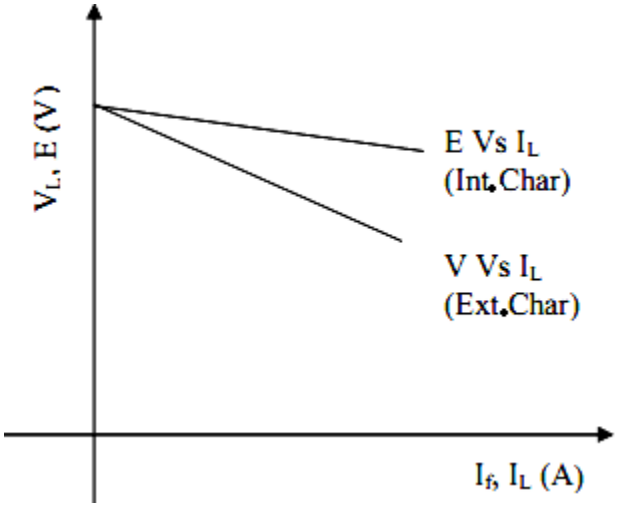
5.After bringing the generator rheostat to maximum position, field rheostat of motor to minimum position, DPST switch is opened.

MODEL GRAPH

OC TEST



LOAD TEST



LOAD TEST:

PRECAUTIONS:

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

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking minimum position of DC shunt motor field rheostat and maximum position of DC shunt generator field rheostat, DPST switch is closed and starting

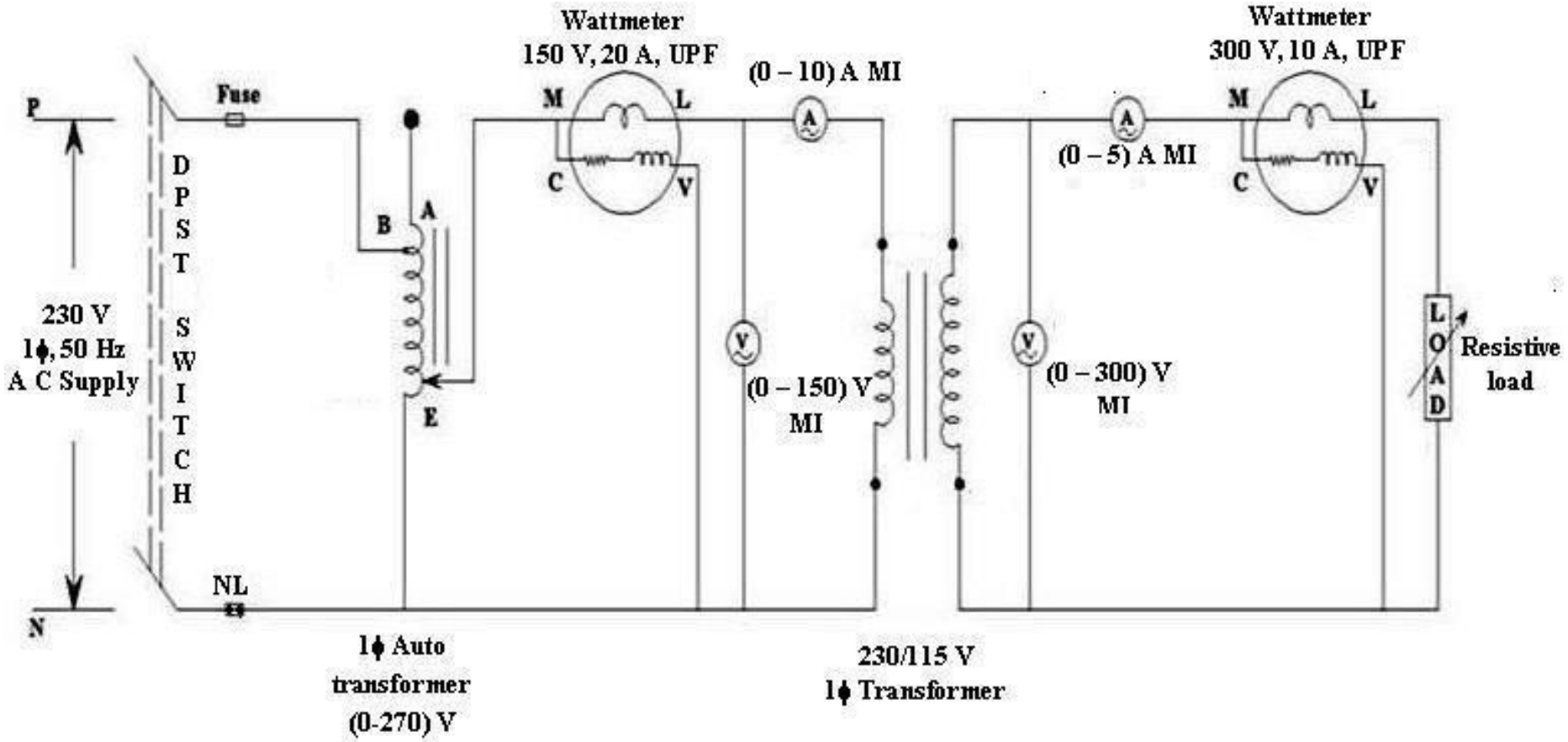
resistance is gradually removed.

3. By adjusting the motor field rheostat, the motor is brought to rated speed.
4. Connect the load by closing load DPST switch.
5. By adjusting the generator field rheostat, the generator is brought to rated voltage
6. Under no load condition, Ammeter and Voltmeter readings are noted.
7. Load is varied gradually and for each load, voltmeter and ammeter readings are noted.
8. Then the generator is unloaded and the field rheostat of DC shunt generator is brought to maximum position and the field rheostat of DC shunt motor to minimum position, DPST switch is opened.

RESULT:

The open circuit characteristics and load characteristics of a self excited DC shunt generator are obtained.

CIRCUIT DIAGRAM



Name Plate Details

EXPERIMENT NO 3

LOAD TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To conduct a direct load test on the given single phase transformer and also to determine the efficiency and the regulation at different load conditions

APPARATUS REQUIRED:

S. No.	Apparatus	Range & Type	Quantity
1	Single Phase Transformer	230/115 V	1 No
2	Single Phase Autotransformer	220/(0-270 V)	1 No
3	Voltmeter AC	(0-150 V), MI (0-300 V), MI	1each
4	Ammeter AC	(0-10 A), MI	1 No
5	Wattmeter	(20A,150 V, UPF)	1 No
6	Resistive load	-	1 No
7	DPST Switch	-	1 No
8	Connecting Wires & Fuse	-	As Required

THEORY:

Direct load test is conducted to determine the efficiency characteristics and regulation characteristics of the given transformer. Transformer is a static device having copper windings and iron core. Eddy current losses and hysteresis losses that together called as iron or constant losses takes place in the iron core. The variable losses or copper losses which are variable with load current takes place in the windings. These losses decide the efficiency of the transformer under different load conditions. An ideal transformer is supposed to give constant secondary voltage irrespective of the load current. But practically, the secondary voltage decreases as the transformer is loaded due to primary and secondary impedance drops. Since these drops are dependent on load current, this variation in terminal voltage is found using direct loading.

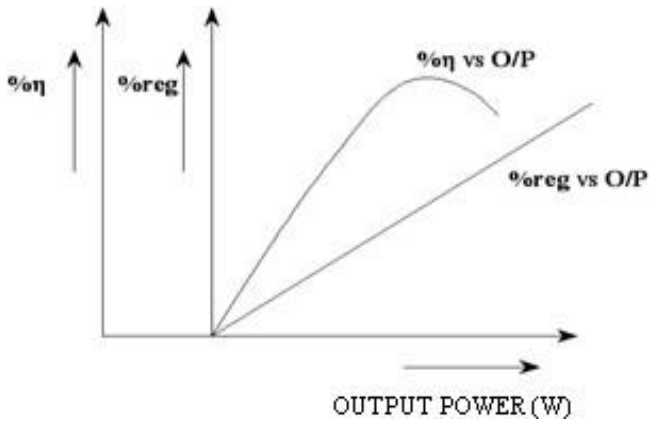
TABULAR COLUMN:

S. No.	LOAD	INPUT			OUTPUT			EFFICIENCY (%)	%Regulation
		V_{LV} (V)	I_{LV} (A)	W_{LV} (W)	V_{HV} (V)	I_{HV} (A)	W_{HV} (W)		

FORMULAE USED:

1. The Output Power of the transformer = $V_{H.V}$ * $I_{H.V}$ on the H.V side
2. The Input Power of the transformer = $W_{L.V}$ = Wattmeter reading on the L.V side
3. % Efficiency (%η) = (OUTPUT / INPUT) * 100
4. % Regulation = $\frac{V_{H.V\,(No\ Load)} - V_{H.V.(Load)}}{V_{H.V\,(No\ Load)}}$ *100

Model Graph



PRECAUTIONS:

1. Remove the fuse carriers and start wiring as per the circuit diagram
2. Fuse rating calculation: Since this is load test, the required fuse rating is only 120% of the rated current of the motor.
3. Keep the autotransformer in its minimum position at the time of starting..
4. Replace the fuse carriers with appropriate fuse wire after the circuit connections

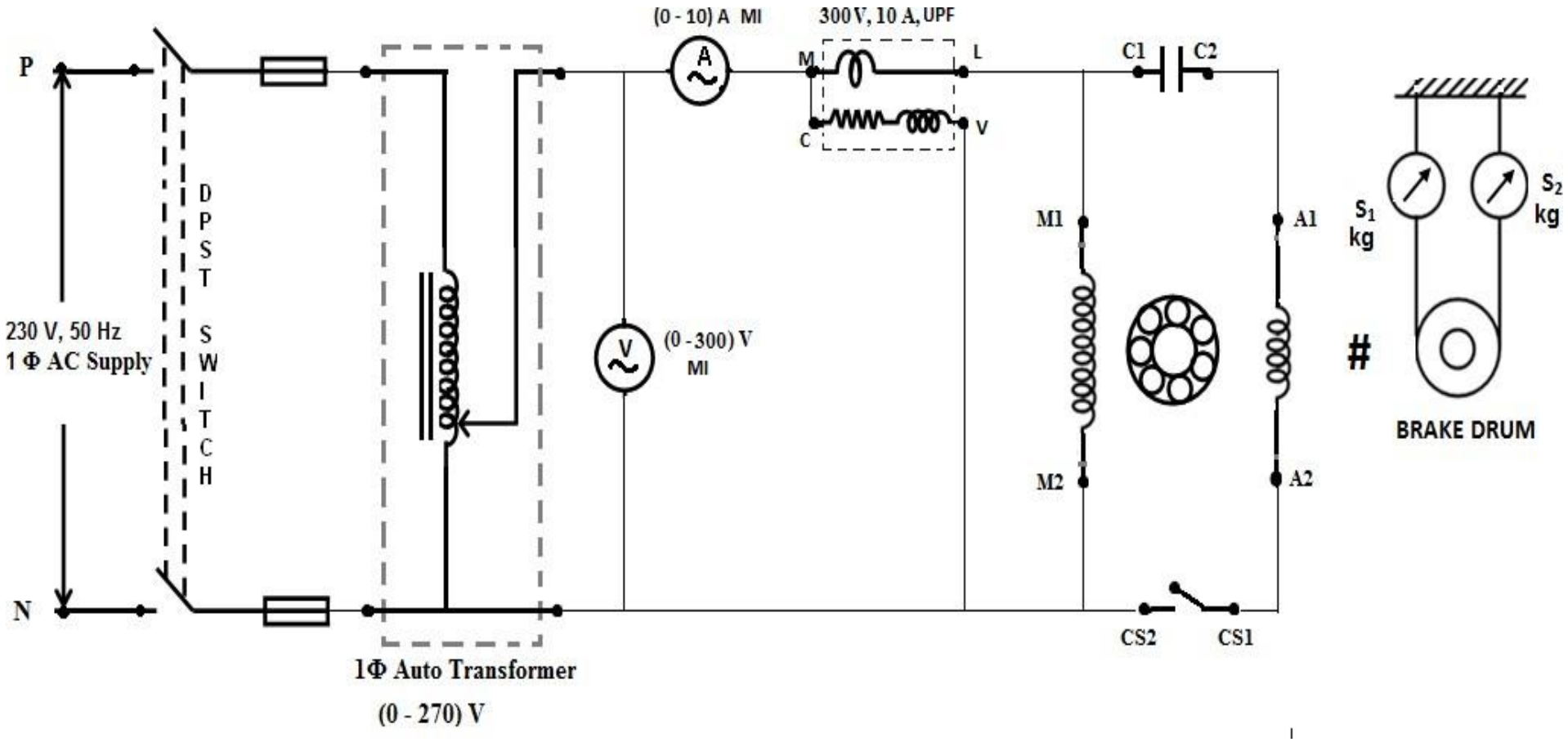
PROCEDURE:

2. The connections are made as per the circuit diagram.
3. Keeping the autotransformer in its minimum position and the DPST switch on load side in open position, the main supply is switched ON.
4. By slowly and carefully operating the autotransformer the rated voltage (115V) is applied to the L.V side of the transformer.
5. Under this no-load condition, one set of readings namely $V_{H.V}$, $I_{H.V}$, $W_{H.V}$, $V_{L.V}$ and $W_{L.V}$, are recorded in the tabular column.
6. The DPST switch on the load side is now closed and the load is increased in gradual steps and at each step primary voltage is maintained at no load voltage and then all meter readings are noted down in the tabular column.
7. The procedure is continued until the current on the H.V side is equal to its full load value.
8. After the experiment is completed, the load is decreased to its minimum, the auto transformer is brought to the minimum position and the supply is switched OFF.
9. After completing the experiment, Output Power, Input Power, Efficiency and Regulation are calculated.
10. Using the data, plot of % Regulation vs Output Power and % Efficiency vs Output Power are drawn in the graph sheets.

RESULT:

A direct load test on the given single phase transformer is determined .

CIRCUIT DIAGRAM



Name Plate details

Rated Voltage : 230v

Rated current : 5A

Circumference = $2\pi r$ =_____cm

Rated Speed : 1500RPM

EXPERIMENT NO 4

LOAD TEST ON SINGLE PHASE INDUCTION MOTOR

AIM:

To draw load characteristics of a single phase induction motor by conducting the load test

APPARATUS REQUIRED:

S. No.	Apparatus	Range	Type	Quantity
1	Single phase induction motor	-	-	1
2	Single phase auto transformer	(0 – 270 V)		1
3	Voltmeter	(0-300) V	MI	1
4	Ammeter	(0-10) A	MI	1
5	Wattmeter	300 V, 10 A, UPF		1
6	Connecting wires	-	-	As required

THEORY:

Constructional of this motor is more or less similar to a poly phase induction motor, except that its stator is provided with a single phase winding. A centrifugal switch is used in some type of motor in order to cut out a winding, used in some type of motor, in order to cut out a winding, used in some type of motors for starting squirrel cage rotor, when fed from a single phase only alternating one which alternates along one phase axis only. Now, alternating or pulsating flux acting on a stationary squired cage rotor cannot produce rotation that is why a single phase motor is not self starting.

PRECAUTIONS:

1. Motor should be started and stopped under no load condition.
2. Brake drum should be cooled with water when it is under load.

PROCEDURE:

1. Connections are made as per the circuit diagram.

2. The DPST switch is closed. The autotransformer is adjusted to get rated voltage and corresponding no load readings are noted down.

TABULAR COLUMN:

S. No	Voltage VL (V)	Current I L (A)	Input Power Pin (W)	Spring Balance Reading		S=S1-S2 (Kg)	Speed N (rpm)	Torque T (Nm)	Output Power Po (W)	Efficiency %	SLIP S	Power Factor Cos Φ
				S1 (Kg)	S2 (Kg)							
1												
2												
3												
4												
5												
6												
7												
8												

Radius of Brake Drum

Circumference = 2 π R =

Radius = R=Circumference / (2 π)

=_____meter

MODEL CALCULATION

3. Gradually increase the load up to the rated current and for each load the corresponding meter readings are tabulated
4. Then load is removed and autotransformer reduced to zero. Then DPST switch opened.

FORMULAE

1. Torque (T)=S*9.81*R Nm
2. Output power (P_O) = $2\pi NT/60$ watts
3. Efficiency (η) = Output power / Input power X 100 %
4. Slip S = (Ns – Nr) / Ns * 100 %
5. Synchronous speed Ns = 120 f / P rpm
6. Power factor cos Φ = P_{in} / (VL *IL)

where,

R – Radius of brakedrum.

VL – Line Voltage

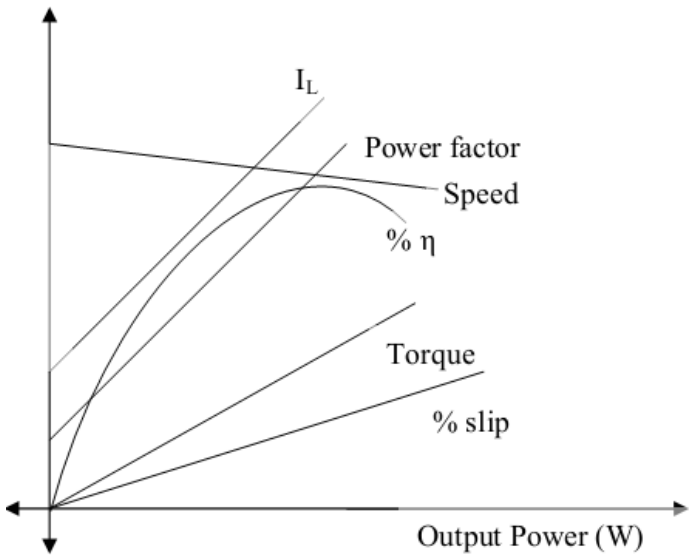
I_L – Line current

N – Speed in rpm

Nr - Rated speed in rpm

T – Torque in Nm

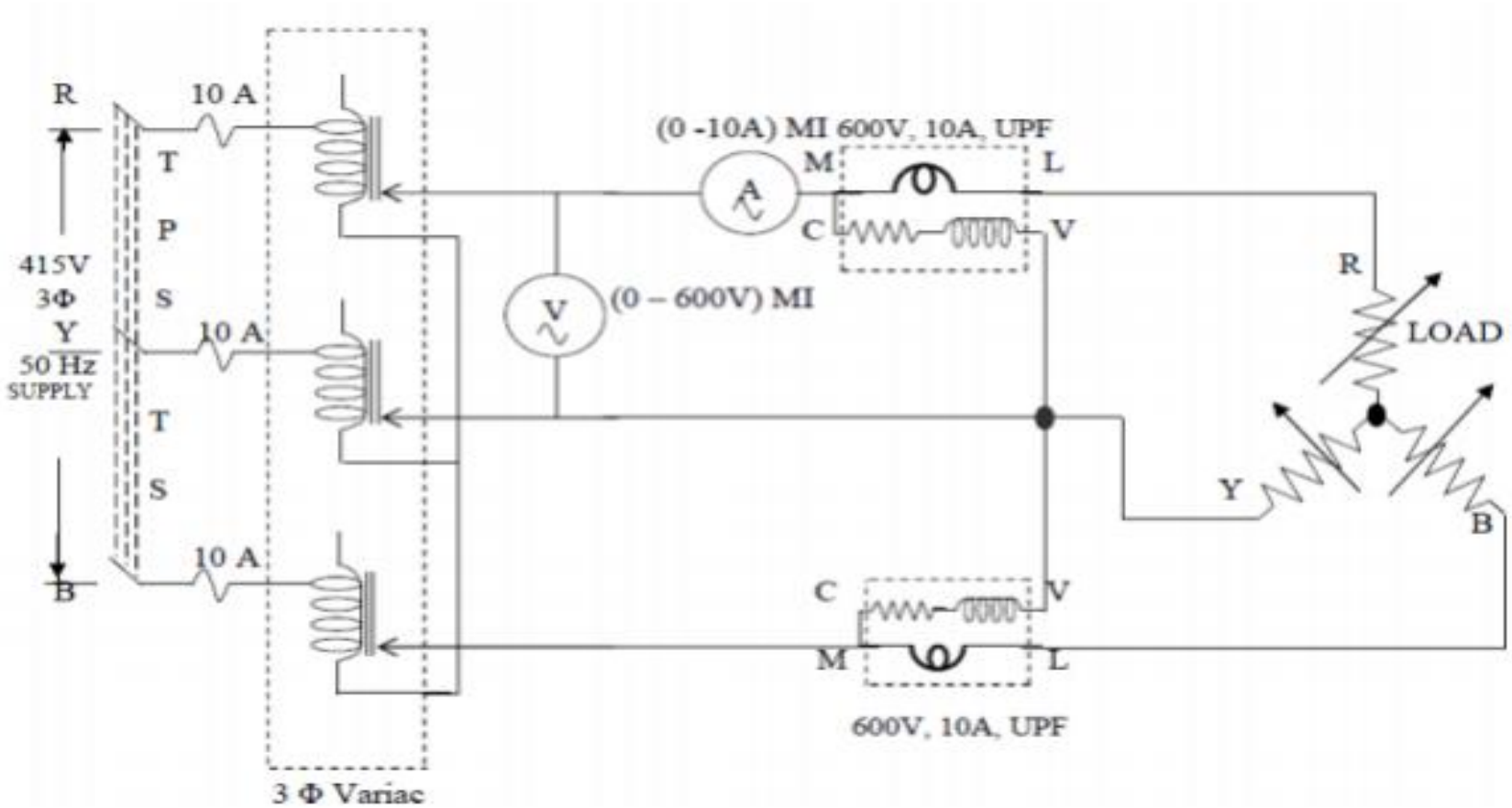
MODEL GRAPH



RESULT:

The load characteristics of a single phase induction motor by conducting the load test are determined.

CIRCUIT DIAGRAM:



EXPERIMENT NO 5

THREE PHASE POWER MEASUREMENT BY USING TWO WATTMETER METHOD

Aim:

To measure three phase power and power factor in a balanced three phase circuit using two single-phase wattmeter.

Apparatus required:

S. No.	Apparatus	Range	Type	Quantity
1	Three phase load	-	-	1
2	Voltmeter	(0-500) V	MI	1
3	Ammeter	(0-5) A	MI	1
4	Wattmeter	600V, 5A, UPF		2
5	Connecting wires	-	-	As required

PRECAUTIONS:

1. The resistive load should be started without any load.
2. The supply should not be switched OFF before the resistive load is unloaded.

PROCEDURE:

1. Connections are made as per the circuit diagram.

2. After checking the no load condition, and minimum auto transformer position, TPST switch is closed.

3. By adjusting the auto transformer apply the rated voltage of the resistive load Ammeter, Voltmeter & wattmeter readings, are noted under no load condition.

OBSERVATIONS:

S. No	Line Voltage (V_L) in Volts	Load current (I_L) in Amps	W1 watts	W2 watts	Real power P in Watts	Power factor Cos ϕ	Sin ϕ	Reactive power Q In VAR	Apparent power S in VA

4. The load is then added gradually and for each load, voltmeter, ammeter, wattmeter are noted up to 80 % of rated current

5. The resistive load is then brought to no load condition and auto transformer is to minimum position, then TPST switch is opened.

FORMULAES:

- The Real power P = (W1+W2) watts
- Power factor Cos $\phi = \pi$ /((1.732* V_L*I_L)
- sin ϕ=(1- Cos2 ϕ)^(1/2)
- Reactive power Q = 1.732* VL* IL * sin ϕ VAR
- Apparent power S=1.732* VL* IL VA

RESULT:

Thus load test on three phase resistive load was conducted and its real, reactive and apparent power determined.