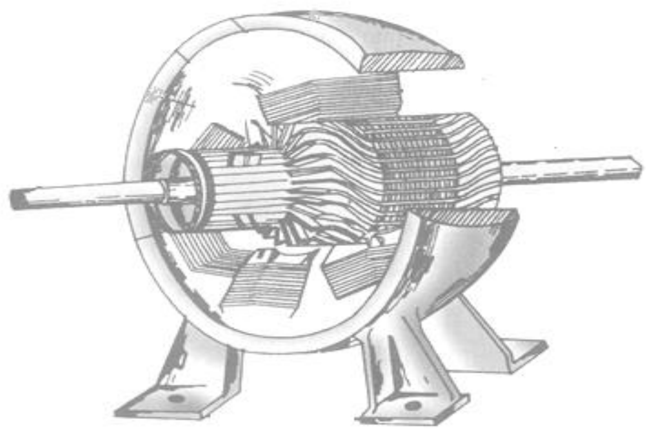
MAHA BARATHI ENGINEERING COLLEGE,CHINNASALEM

DEPARTMENT OF EEE



Electrical machines - I

Lab manual

1. Open circuit and load characteristics of separately and self excited DC shunt generators.
2. Load characteristics of DC compound generator with differential and cumulative connection.
3. Load characteristics of DC shunt and compound Motor.
4. Load characteristics of DC series motor.
5. Swinburne's test and speed control of DC shunt motor.
6. Hopkinson's test on DC motor - generator set.
7. Load test on single-phase transformer and three phase transformer connections.
8. Open circuit and short circuit tests on single phase transformer.
9. Sumner's test on transformers.
10. Separation of no-load losses in single phase transformer.
11. Study of starters and three phase transformer connections.

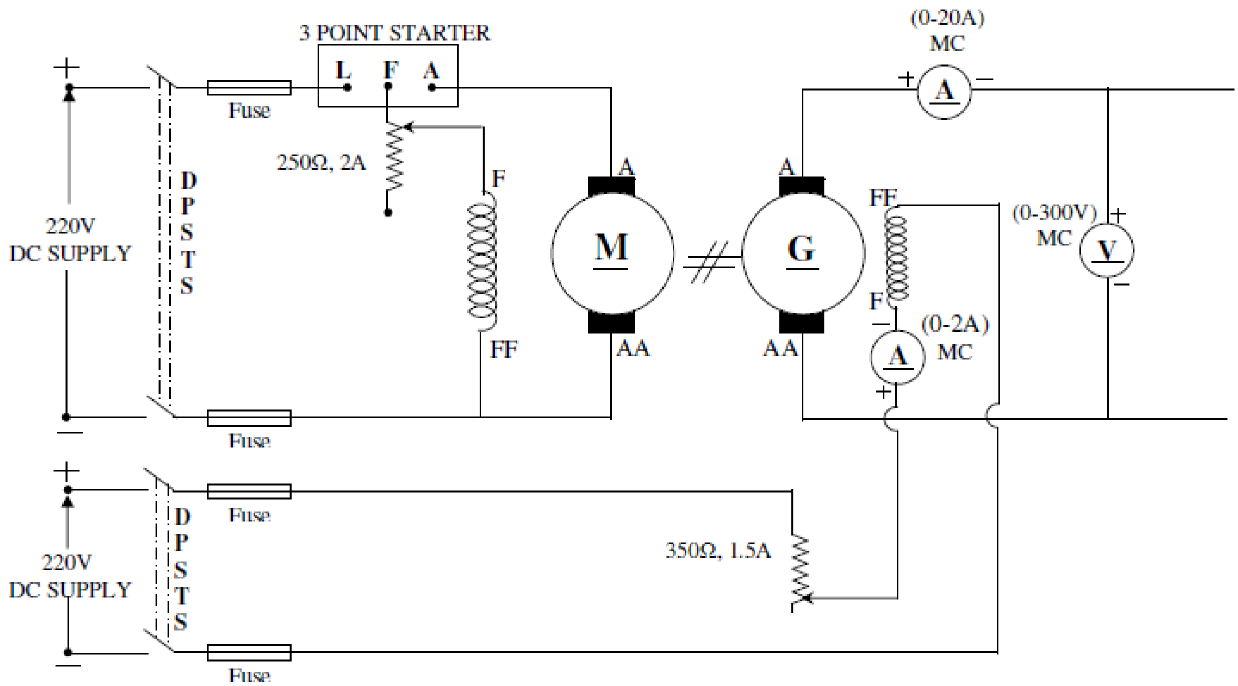
TOTAL:

EE6411-Electrical machines - I

LIST OF EXPERIMENTS

S.NO	DATE	TITLE	PAGE NO	MARKS
1		(a)OPEN CIRCUITAND LOAD CHARACTERISTICS OF SEPERATELY EXCITED D.C SHUNT GENERATOR (b)OPEN CIRCUITAND LOAD CHARACTERISTICS OF SELF EXCITED D.C SHUNT GENERATOR		
2		LOAD CHARACTERISTICS OF DC COMPOUND GENERATOR WITH DIFFERENTIAL AND CUMULATIVE CONNECTION		
3		(a)LOAD CHARACTERISTICS OF DC SHUNT MOTOR (b)LOAD CHARACTERISTICS OF DC COMPOUND MOTOR.		
4		LOAD CHARACTERISTICS OF DC SERIES MOTOR.		
5		(i) SPEED CONTROL OF D.C. SHUNT MOTOR (ii) SWINBURNE’S TEST		
6		HOPKINSON'S TEST ON DC MOTOR - GENERATOR SET.		
7		(i)LOAD TEST ON SINGLE-PHASE TRANSFORMER (ii)STUDY OF THREE PHASE TRANSFORMER CONNECTIONS.		
8		OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER.		
9		SUMPNER'S TEST ON TRANSFORMERS.		
10		SEPARATION OF NO-LOAD LOSSES IN SINGLE PHASE TRANSFORMER.		

CIRCUIT DIAGRAM FOR OC TEST:



TABULATION:

S.No	I_f (in Amps)	E_g(in volts)

EXP NO :1(a)

DATE:

OPEN CIRCUIT AND LOAD CHARACTERISTICS OF D.C SEPERATELY EXCITED SHUNT GENERATOR

AIM:

To conduct open circuit and load test on a given separately excited D.C shunt generator and to obtain the characteristics.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Type	Range	Quantity
1	Voltmeter	(0-300) V	M.C	1
2	Ammeter	(0-10) A (0-2) A	M.C M.C	1 1
3	Tachometer		Analog	1
4	Rheostat	230 ohm,1.7A	Wire wound	2
5	single phase Resistive load	5kw	---	1
6	Connecting wires	--	---	As required

PROCEDURE:

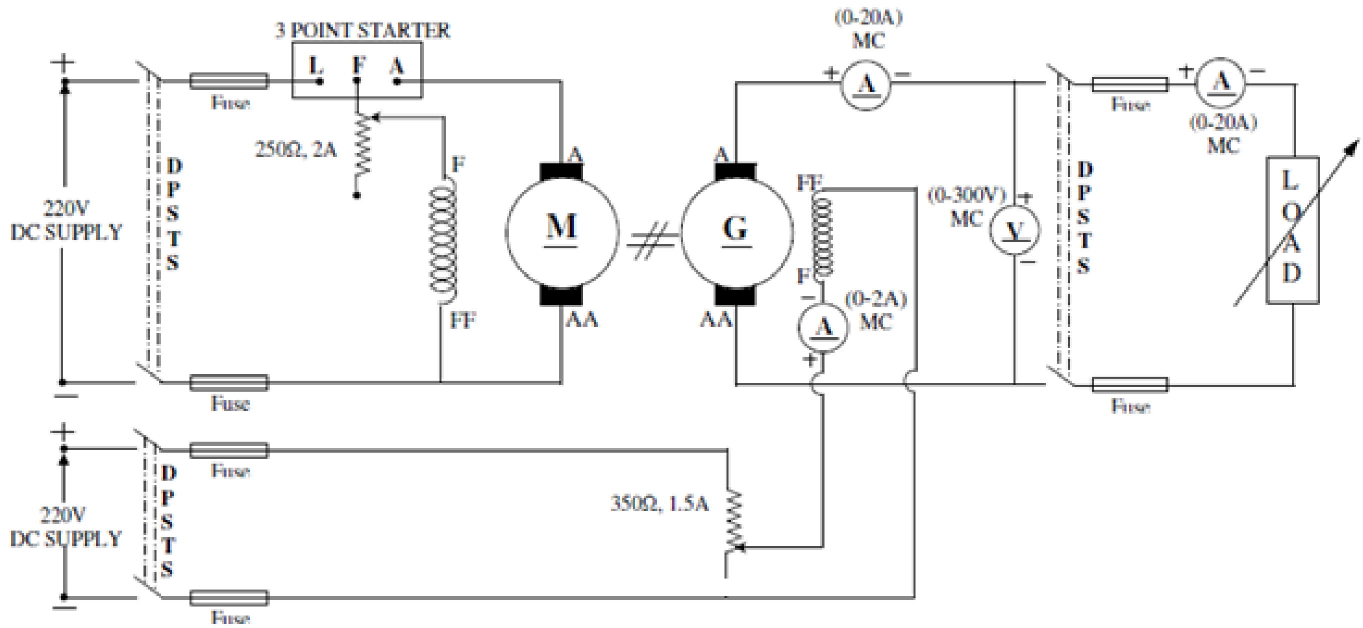
Open circuit test :

1) To give the connection as per the circuit diagram.
2) Switch on the MCB.
3) To start the motor by using 3-point starter.
4) Then set the motor (prime mover) speed is equal to synchronous speed by adjusting the motor field rheostat.
5) To kept open position in generator side DPSTS.
6) Note down the voltmeter reading at I_f is zero.
7) Then apply the field current and adjust the generator field rheostat in step by step also note down the ammeter and voltmeter reading in each step.
8) Then switched off the prime mover by using MCB.

Load test :

1) To give the connection as per the circuit diagram.
2) Switch on the MCB.
3) To start the motor (prime mover) by using 3-point starter.
4) Then set the motor (prime mover) speed is equal to synchronous speed by adjusting the motor field rheostat.

CIRCUIT DIAGRAM FOR LOAD TEST:



TABULATION:

Armature resistance R_a =

S.NO	Load Voltage (V_L)	Field Current (If)	Load Current (I_L)	$I_a = I_L$	$Eg = V_L + I_a R_a$

5) Set the terminal voltage in generator site in rated by adjusting the generator field rheostat.
6) Switch on the generator side DPSTS.

7) Then apply the load in step by step also note down the ammeter and voltmeter reading in each step.
8) Then switched off the prime mover by using MCB.

FORMULA USED:

Open circuit test:

Field resistance $R_F = \Delta_{E1} / I_{F1} = E_1 - E_o / I_{F1}$

Critical field resistance $Rc = \Delta_{E2} / I_{F2}$

Load Test:

$Ia = I_L$ $Eg = V_L + I_a R_a$

MODEL GRAPH:

Open circuit test

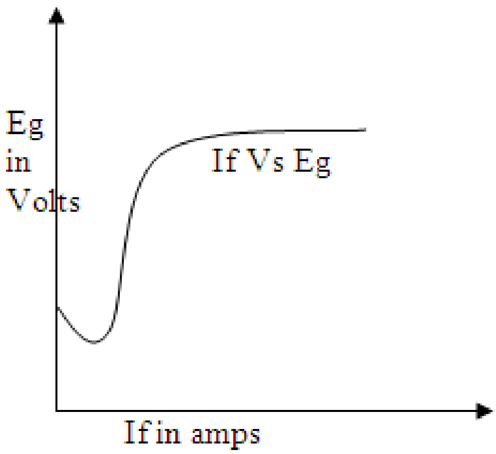
- Field current Vs Open circuit voltage (If Vs Eg)

Load test:

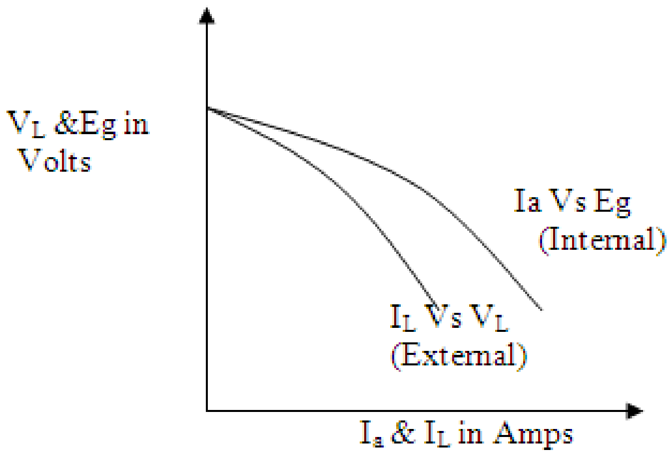
- Armature current Vs Generated voltage
  (Internal Characteristics) (Ia Vs Eg)

- Load current Vs Load voltage
  (External Characteristics) (I_L Vs V_L)

Open circuit test:

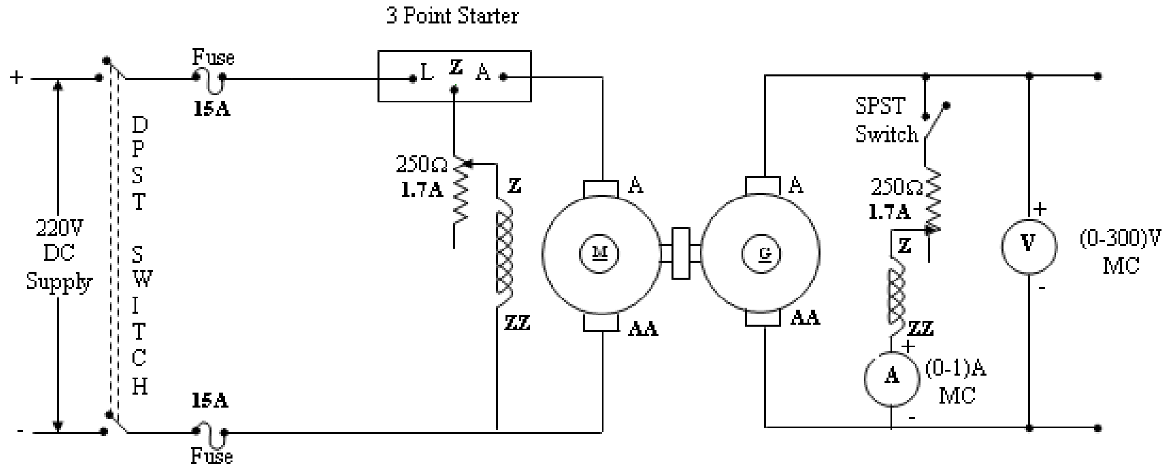


Load test:



RESULT:

CIRCUIT DIAGRAM FOR OC TEST:



FUSE RATING:

125% of rated current

NAME PLATE DETAILS:

	Motor	Generator
Rated Voltage :	220V	220V
Rated Current :		
Rated Power :		
Rated Speed :	1500 RPM	1500 RPM

TABULAR COLUMN:

OPEN CIRCUIT TEST:

S.No	If(in Amps)	Eg(in volts)

EXP NO :1(b)

DATE:

OPEN CIRCUIT AND LOAD CHARACTERISTICS OF D.C SELF EXCITED SHUNT GENERATOR

AIM:

To conduct open circuit and load test on self-excited D.C shunt generator and to obtain the characteristics.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Range	Type	Quantity
1	Voltmeter	(0-300) V	M.C	1
2	Ammeter	(0-10) A (0-2) A	M.C M.C	1 1
3	Tachometer		Analog	1
4	Rheostat	230 ohm,1.7A	Wire wound	2
5	Single phase Resistive load	5kw	---	1
6	Connecting wires	--	---	As required

PROCEDURE:

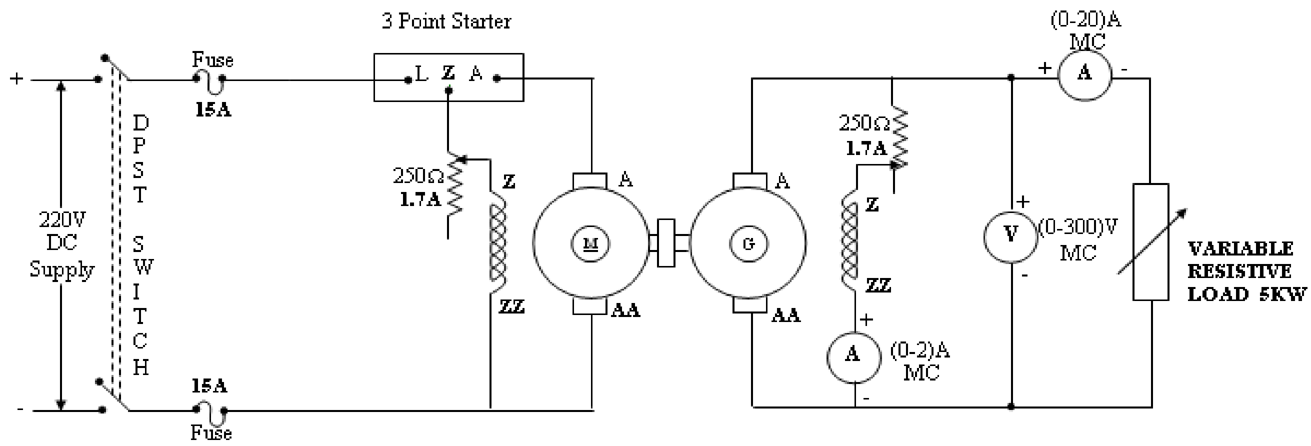
<u>Open circuit test :</u>

1) To give the connection as per the circuit diagram.
2) Switch on the MCB.
3) To start the motor by using 3-point starter.
4) Then set the motor (prime mover) speed is equal to synchronous speed by adjusting the motor field rheostat.
5) To kept open position in generator side DPSTS.
6) Note down the voltmeter reading at I_f is zero.
7) Then apply the field current and adjust the generator field rheostat in step by step also note down the ammeter and voltmeter reading in each step.
8) Then switched off the prime mover by using MCB.

<u>Load test :</u>

1) To give the connection as per the circuit diagram.
2) Switch on the MCB.
3) To start the motor (prime mover) by using 3-point starter.
4) Then set the motor (prime mover) speed is equal to synchronous speed by adjusting the motor field rheostat.

CHARACTERISTICS OF DC SELF EXCITED GENERATOR



LOAD TEST

Armature resistance R_a =

S.NO	Load Voltage (V_L)	Field Current (If)	Load Current (I_L)	$I_a = I_L + If$	$Eg = V_L + I_a R_a$

5) Set the terminal voltage in generator site in rated by adjusting the generator field rheostat.
6) Switch on the generator side DPSTS.

7) Then apply the load in step by step also note down the ammeter and voltmeter reading in each step.
8) Then switched off the prime mover by using MCB.

FORMULA USED:

Open circuit test:

Field resistance $R_F = \Delta_{E1} / I_{F1} = E_1 - E_o / I_{F1}$

Critical field resistance $Rc = \Delta_{E2} / I_{F2}$

Load test:

$Ia = I_L + I_f$ $\quad$ $Eg = V_L + Ia\ Ra$

MODEL GRAPH:

Open circuit test

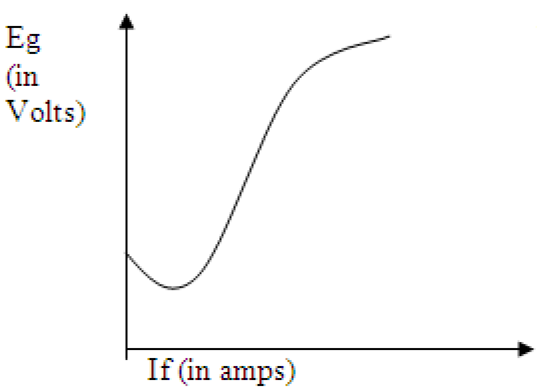
- Field current Vs Open circuit voltage (If Vs Eg)

Load test:

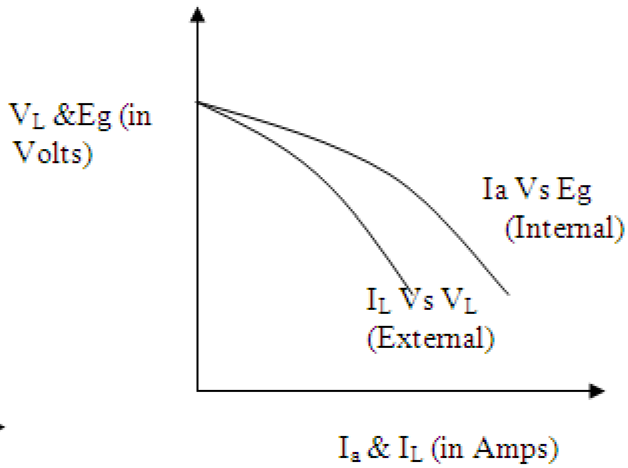
- Armature current Vs Generated voltage (Internal Characteristics) (Ia Vs Eg)

- Load current Vs Load voltage (External Characteristics) (I_L Vs V_L)

Open circuit test:



Load test:



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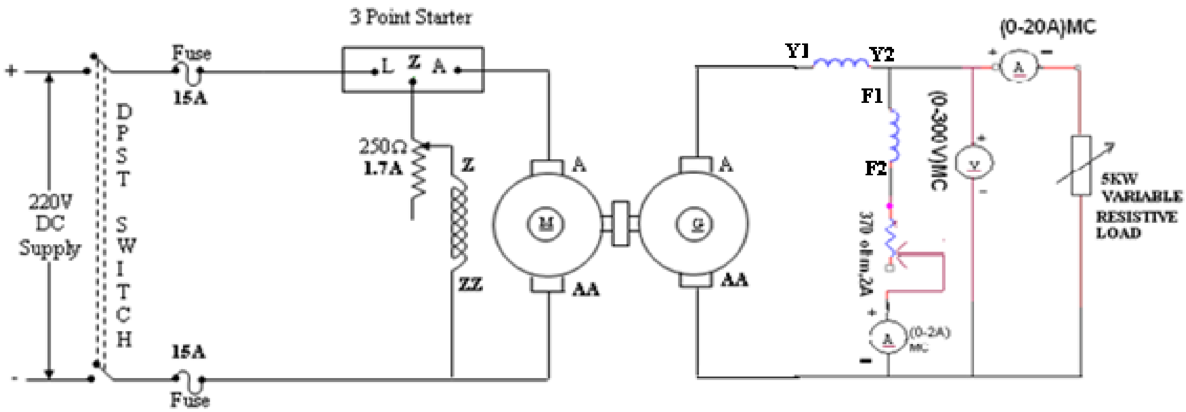
RESULT:

CIRCUIT DIAGRAM



FUSE RATING:

125% of rated current

NAME PLATE DETAILS:

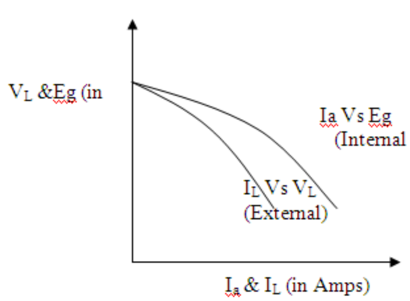
	Motor	Generator
Rated Voltage :	220V	220V
Rated Current :		
Rated Power :		
Rated Speed :	1500 RPM	1500 RPM

LOAD TEST(cummulative)

Armature resistance R_a =   Series Resistance (Rse) =

S.NO	Load Voltage (V_L)	Field Current (If)	Load Current (I_L)	$I_a = I_L + I_f$	$Eg = V_L+I_a(R_a+R_{se})$

MODEL GRAPH:



EXP NO: 2

DATE:

LOAD CHARACTERISTICS ON DC COMPOUND GENERATOR

AIM:

To perform load test on DC Compound generator and obtain characteristics curves.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Type	Range	Quantity
1	Voltmeter	(0-300) V	M.C	1
2	Ammeter	(0-20) A (0-2) A	M.C M.C	1 1
3	Tachometer		Analog	1
4	Rheostat	230 ohm, 1.7A	Wire wound	2
5	Single Phase Resistive load	5kw	---	1
6	Connecting wires	--	---	As required

PROCEDURE:

Load test :

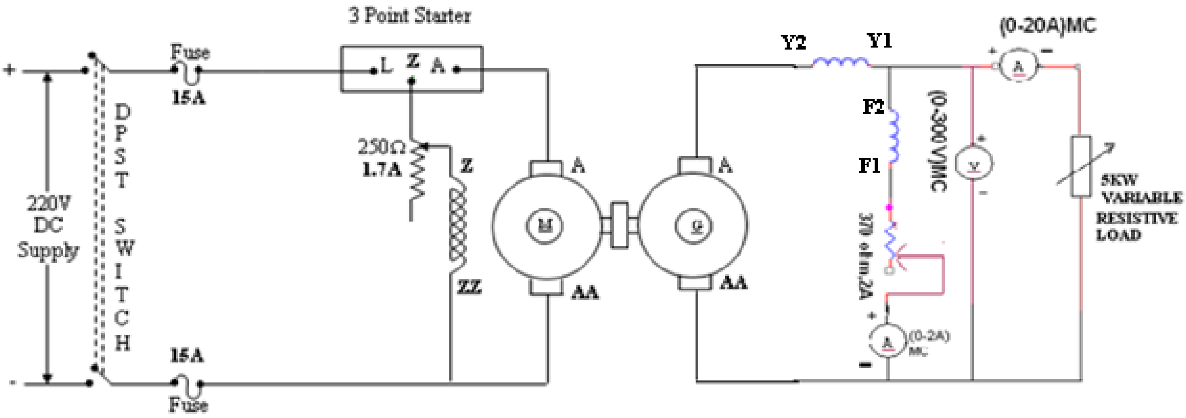
1) To give the connection as per the circuit diagram.
2) Switch on the MCB.
3) To start the motor (prime mover) by using 3-point starter.
4) Then set the motor (prime mover) speed is equal to synchronous speed by adjusting the motor field rheostat
5) Set the terminal voltage in generator site in rated by adjusting the generator field rheostat.
6) Switch on the generator side DPSTS.
7) Then apply the load in step by step also note down the ammeter and voltmeter reading in each step.
8) Then switched off the prime mover by using MCB.

FORMULA USED:

$Ia = I_L + I_f$

$Eg = V_L + Ia\ [Ra + R_{se}$

CIRCUIT DIAGRAM



FUSE RATING:

125% of rated current

NAME PLATE DETAILS:

	Motor	Generator
Rated Voltage :	220V	220V
Rated Current :		
Rated Power :		
Rated Speed :	1500 RPM	1500 RPM

LOAD TEST(differential)

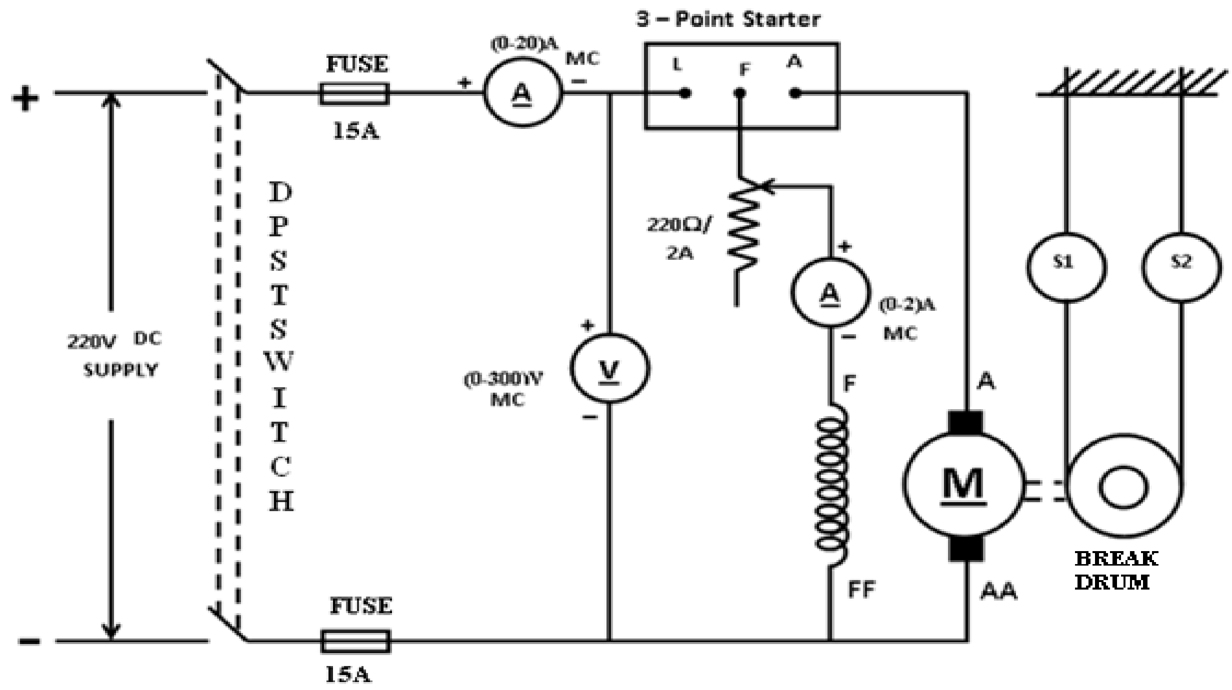
Armature resistance R_a = Series Resistance (Rse) =

S.NO	Load Voltage (V_L)	Field Current (If)	Load Current (I_L)	$I_a = I_L + I_f$	Eg = $V_L+I_a(R_a+R_{se})$

MODEL CALCULATION:

RESULT:

CIRCUIT DIAGRAM:



FUSE RATING **NAME PLATE DETAILS**

TABULAR COLUMN

Sl. No.	Voltage, V_L (V)	Current I_L (A)	Spring balance		Speed Rpm	Torque N-m	Input P_i watts	Output P_0 watts	Efficiency In %
			S_1 Kg	S_2 Kg					

EXP NO:3(a)

DATE :

LOAD TEST ON DC SHUNT MOTOR

AIM:

To perform Load test on DC shunt motor and to draw the characteristics and performance curves.

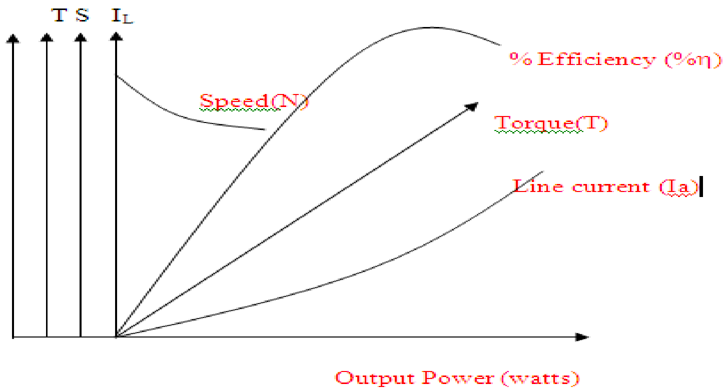
APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Range	Type	Quantity
1	Voltmeter	(0-300) V	M.C	1
2	Ammeter	(0-20) A	M.C	1
3	Tachometer		Analog	1
4	Rheostat	220 ohm,2A	Wire wound	1
5	Connecting wires	--	---	As required

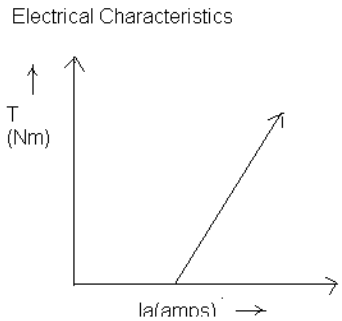
PROCEDURE:

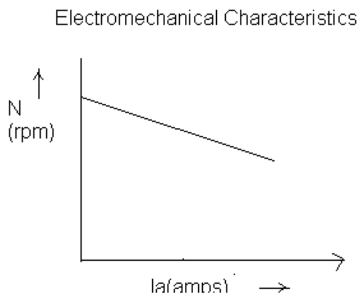
1. The Connections are made as per the circuit diagram.
2. The Field Rheostat is kept at minimum position.
3. The supply is given by closing DPSTS and by using 3- point starter motor is started.
4. The speed of the motor is adjusted to the rated value by varying field rheostat.

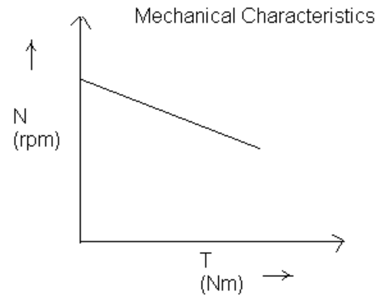
Performance curves:



Characteristics curves:







5. Now the load is applied on the brake drum and the corresponding ammeter and voltmeter readings are noted.

6. This procedure is repeated for different values of load up to the rated value of armature current.

7. Now the load is reduced and the supply is disconnected

FORMULA USED:

Input Power $(P_i) = V_L I_L$ watts

Torque (T) = $(S_1 - S_2)$ x R x 9.81 N-m

Where,

R- Radius of the brake drum in meter

Output Power (Po) = 2ΠNT/60 watts

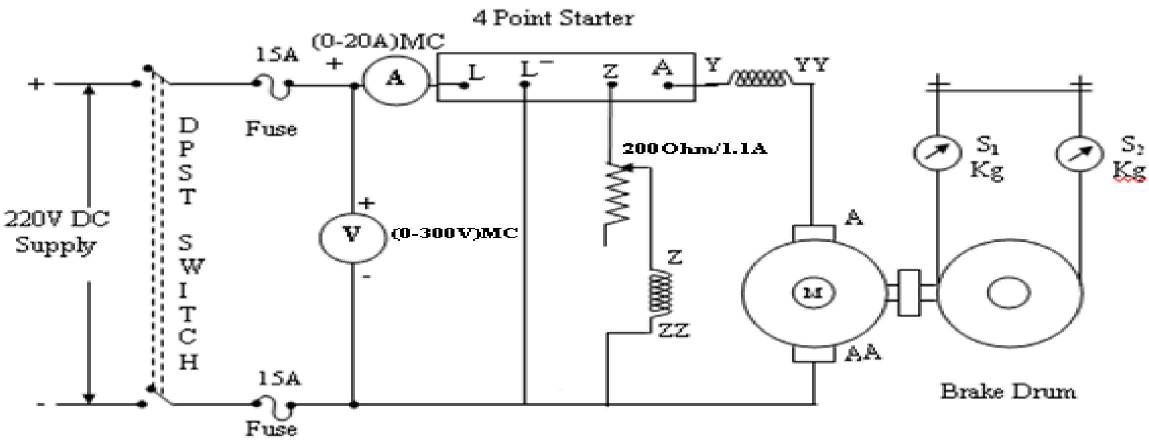
$$\% \text{ Efficiency} = \frac{\text{Output Power (Po)}}{\text{Input Power (Pi)}}$$

SHUNT MOTOR CHARECTERISTICS

- N Vs Ia
  - N = k (V – Ia Ra) / Φ
  - Ish and Φ are nearly constant
  - Speed nearly constant except Ia Ra drop.
- T Vs Ia
  - T α Ia (Φ = constant)
  - T ↑ ; Ia ↑
- N Vs T
  - Ia ↑ ; N ↓ ; T ↑

RESULT:

CIRCUIT DIAGRAM:



FUSE RATING: **NAME PLATE DETAILS**

TABULAR COLUMN:

S.No.	Voltage V (Volts)	Current I (Amps)	Spring Balance Reading		$(S_1 \sim S_2)$ Kg	Speed N (rpm)	Torque T (Nm)	Output Power Pm (Watts)	Input Power P_i (Watts)	Efficiency η%
			S_1(Kg)	S_2(Kg)						

EXP NO: 3(b)

DATE:

LOAD TEST ON DC COMPOUND MOTOR

AIM:

To conduct load test on DC compound motor and to find its efficiency.

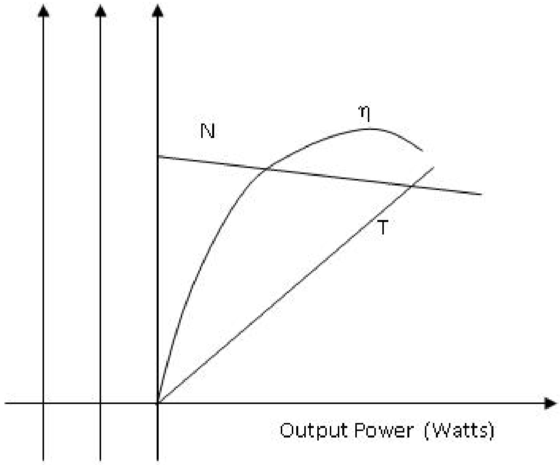
APPARATUS REQUIRED:

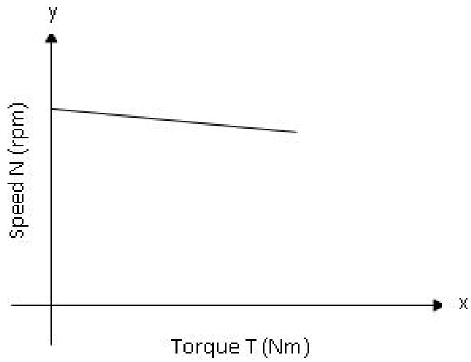
S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-20)A	MC	1
2	Voltmeter	(0-300)V	MC	1
3	Rheostat	200Ω, 1.1A	Wire Wound	1
4	Tachometer	(0-1500) rpm	Digital	1
5	Connecting Wires	2.5sq.mm.	Copper	Few

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, and minimum field rheostat position, DPST switch is closed and starter resistance is gradually removed.
3. The motor is brought to its rated speed by adjusting the field rheostat.
4. Ammeter, Voltmeter readings, speed and spring balance readings are noted under no load condition.
5. The load is then added to the motor gradually and for each load, voltmeter, ammeter, spring balance readings and speed of the motor are noted.
6. The motor is then brought to no load condition and field rheostat to minimum position, then DPST switch is opened.

MODEL GRAPH:





<u>MODEL CALCULATION:</u>

FORMULA USED:

Circumference of brake drum = $2 \times \pi \times R$ in meter

R – Radius of the brake drum

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

Input power, $P_i = V_L \times I_L$ in Watts

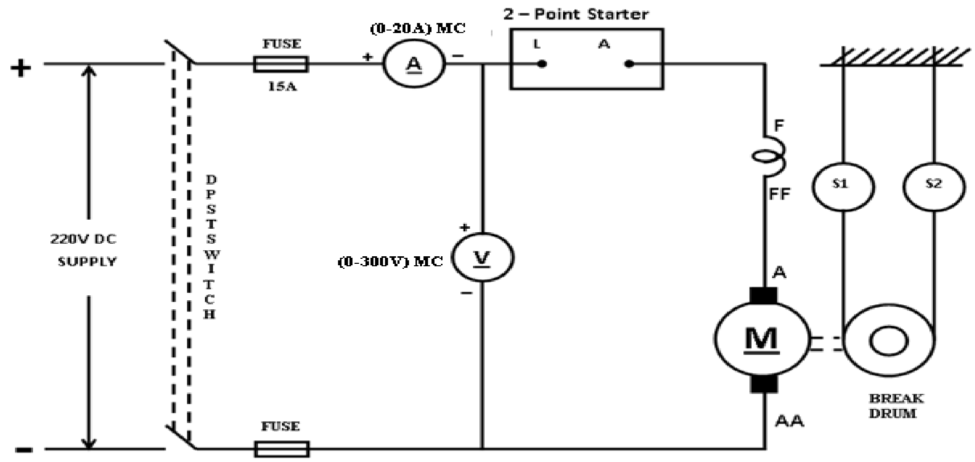
Output power, $P_m = (2 \times \pi \times N \times T) / 60$ in Watts

% Efficiency, $\eta = (P_m / P_i) \times 100$

RESULT:

LOAD TEST ON DC SERIES MOTOR

CIRCUIT DIAGRAM:



FUSE RATING **NAME PLATE DETAILS**

TABULAR COLUMN:

Sl. No.	Voltage, V_L (V)	Current I_L (A)	Spring balance		Speed Rpm	Torque N-m	Input P_i watts	Output P_0 watts	Efficiency In %
			S_1 Kg	S_2 Kg					

EXP NO: 4
DATE :

LOAD TEST ON DC SERIES MOTOR

AIM:

To perform Load test on DC Series motor and to draw the characteristics and performance curves.

APPARATUS REQUIRED:

Sl.No	Name of the apparatus	Range	Type	Quantity
1	Voltmeter	(0-300) V	M.C	1
2	Ammeter	(0-20) A	M.C	1
3	Tachometer		Analog	1
4	Connecting wires	--	---	As required

FORMULA USED:

Circumference of brake drum = $2 \times \pi \times R$ in Meter

R – Radius of the brake drum

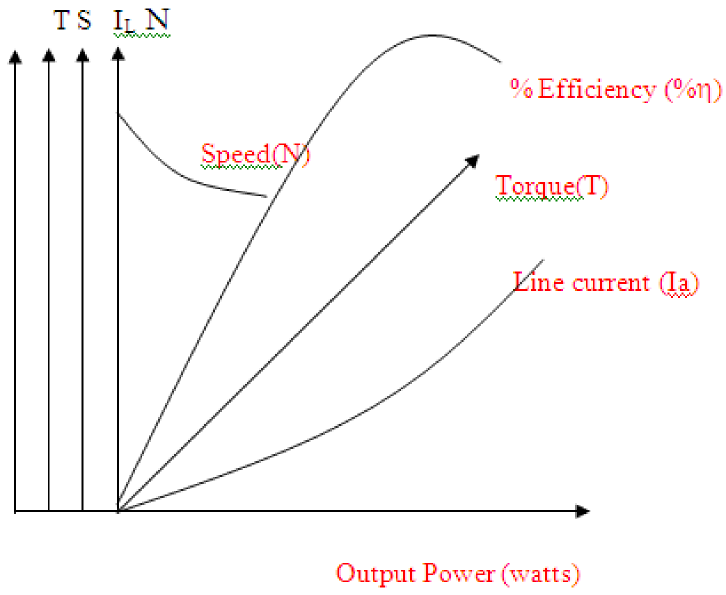
Torque, $T = (S_1 - S_2) \times 9.81 \times R$ in Nm

Input power, $P_i = V_L \times I_L$ in Watts

Output power, $P_0 = (2 \times \pi \times N \times T) / 60$ in Watts

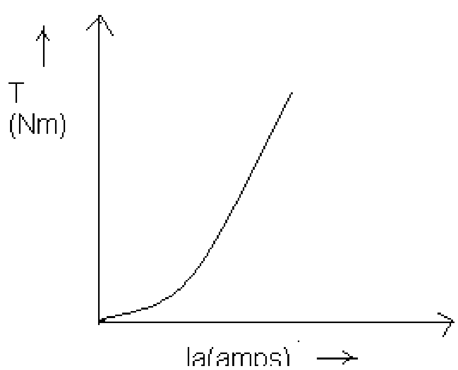
% Efficiency, $\eta = (P_0 / P_i) \times 100$

PERFORMANCE CURVES:

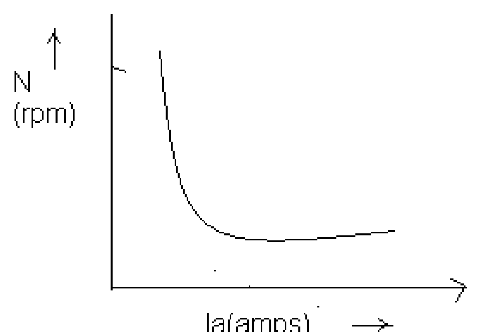


CHARACTERISTICS CURVES:

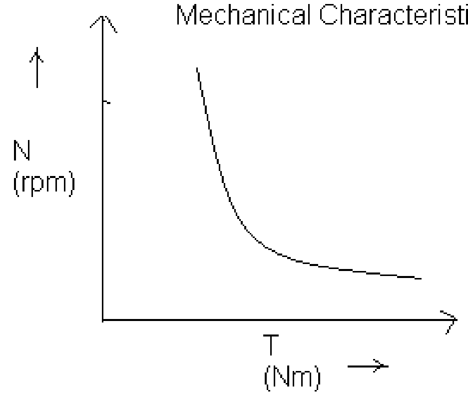
Electrical Characteristics



Electromechanical Characteristics



Mechanical Characteristics

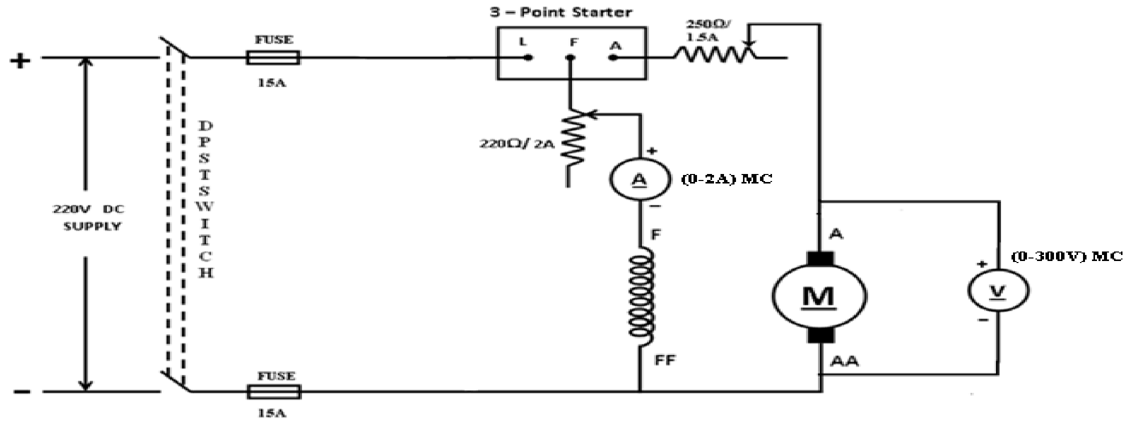


MODEL CALCULATION:

RESULT:

SPEED CONTROL OF DC SHUNT MOTOR

CIRCUIT DIAGRAM:



FUSE RATING **NAME PLATE DETAILS**

(i) Armature Voltage Control:

S.No.	I_{f1} =		I_{f2} =	
	Armature Voltage V_a (Volts)	Speed N (rpm)	Armature Voltage V_a (Volts)	Speed N (rpm)

EXP NO: 5(a)

DATE:

SPEED CONTROL OF DC SHUNT MOTOR

AIM:

To control the speed of the dc shunt motor by using armature control and field control method.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-20) A	MC	1
2	Voltmeter	(0-300) V	MC	1
3	Rheostats	250Ω, 1.5A	Wire Wound	Each 1
4	Tachometer	(0-3000) rpm	Digital	1
5	Connecting Wires	2.5sq.mm.	Copper	Few

PROCEDURE:

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

(i) Armature Control:

1. Field current is fixed to various values and for each fixed value, by varying the armature rheostat, speed is noted for various voltages across the armature.

(ii) Field Control:

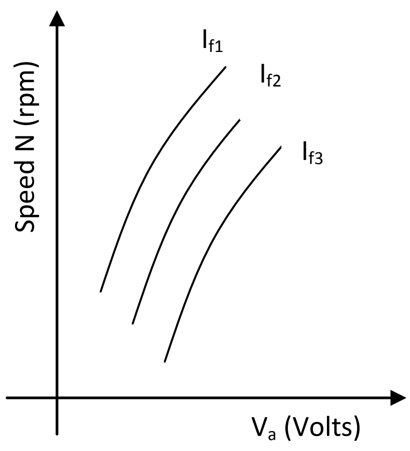
1. Armature voltage is fixed to various values and for each fixed value, by adjusting the field rheostat, speed is noted for various field currents.

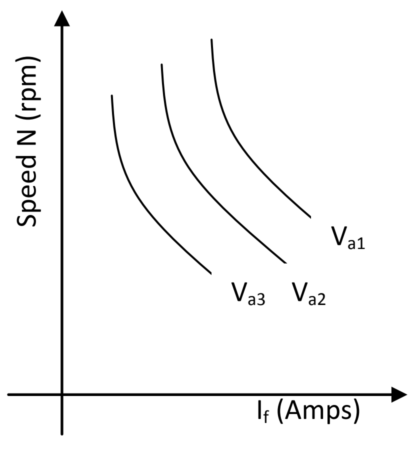
2. Bringing field rheostat to minimum position and armature rheostat to maximum position DPST switch is opened.

Field Control:

S.No.	V_{a1} =		V_{a2} =	
	Field Current I_f (A)	Speed N (rpm)	Field Current I_f (A)	Speed N (rpm)

MODEL GRAPHS:



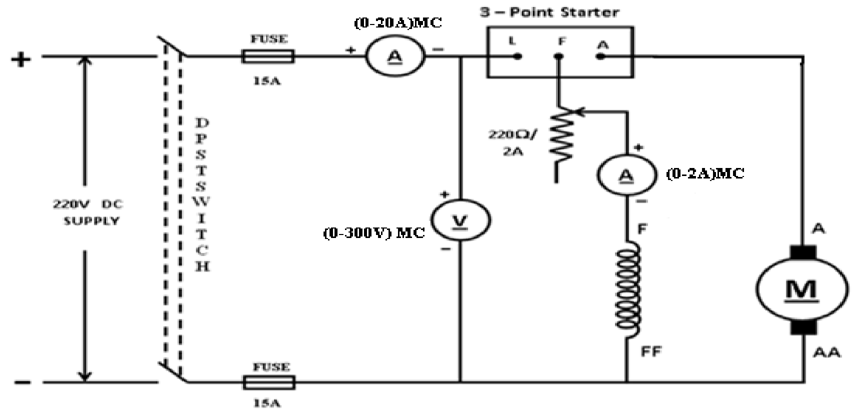


MODEL CALCULATION:

RESULT:

SWINBURNE'S TEST OF D.C. SHUNT MOTOR

CIRCUIT DIAGRAM: -



NAME PLATE DETAILS

TABULAR COLUMNS

(i) Motor on No Load

V_O Volts	I_O Amps	I_f Amps	$I_a = I_O - I_f$ Amps	Speed (N) RPM
				1500

EXP NO: 5(b)

DATE :

SWINBURNE'S TEST OF D.C. SHUNT MOTOR

AIM:

To perform Swinburne's test and to predetermine the efficiency of a given D.C. Shunt machine

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-20) A	MC	1
2	Voltmeter	(0-300) V	MC	1
3	Rheostats	250Ω, 1.5A	Wire Wound	Each 1
4	Tachometer	(0-3000) rpm	Digital	1
5	Connecting Wires	2.5sq.mm.	Copper	Few

PROCEDURE:

1. Connections are made as per the circuit diagram.

2. The supply is switched ON by closing the DPST switch.

3. The field rheostat is adjusted till the motor attains its rated speed.

4. The readings of the ammeters and voltmeter are noted under no load conditions.

5. The rheostat is brought back to the minimum position and the supply is switched OFF.

6. The DC resistance of the armature is determined using a voltmeter and an ammeter.

.

PREDETERMINATION OF LOSSES AND EFFICEINCY AT DIFFERENT LOADS:

(i) As a Motor:

SL. NO	Load Voltage V_L Volts	Load Current I_L Amps	Armature Current Ia Amps	Copper losses Ia^2 Ra Watts	Total losses Wi + Wc Watts	Input Power V_L I_L Watts	Output Power I/P -losses Watts	Efficiency η %
1								
2								
3								
4								

FORMULA:

Constant Losses $Wc = Vo – (Io – I_f)^2$ Ra Watts

As a Motor:

Input power = $V_L I_L$ Watts

Ia $= I_L –$ If Amps

Armature Cu loss = Ia^2 Ra Watts

Total Loss = Wc + Cu loss Watts

Output power = Input – Total loss Watts

% Efficiency = Output/Input * 100

As a Generator:

Ia $= I_L +$ If Amps

Armature Cu loss = Ia^2 Ra Watts

Total Loss = Wc + Cu loss Watts

Output power = $V_L I_L$ Watts

Input power = Output + Total loss Watts

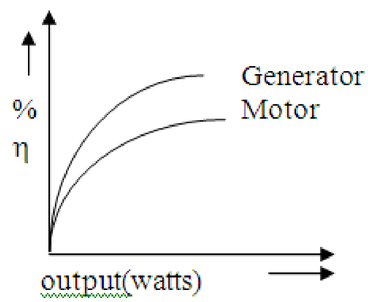
% Efficiency = Output/Input

(ii) As a Generator:

SL. NO	Load Voltage V_L Volts	Load Current I_L Amps	Armature Current Ia Amps	Copper losses $Ia^2 Ra$ Watts	Total losses Wi + Wc Watts	Output Power $V_L I_L$ Watts	Input Power O/p+losses Watts	Efficiency η %
1								
2								
3								
4								

MODEL GRAPH:

1. Output power Vs efficiency (as a motor)
2. Output power Vs efficiency (as a generator)



MODEL CALCULATION:

RESULT:

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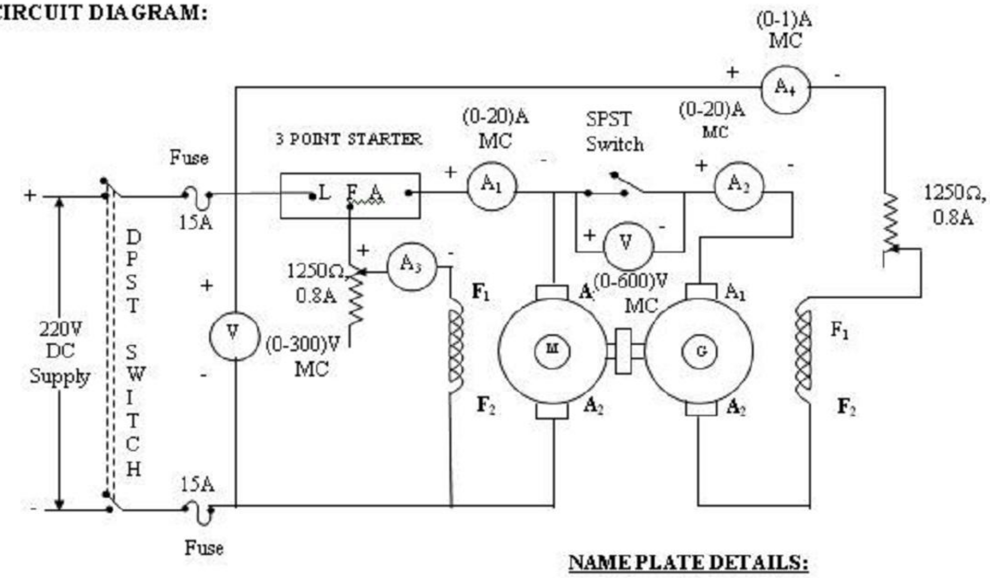
CIRCUIT DIAGRAM:



NAME PLATE DETAILS:

	SHUNT MOTOR	SHUNT GENERATOR
Rated Voltage :	220V	220V
Rated Current :	21A	21A
Rated Power :	3.5KW	7.5KW
Rated Speed :	1500 rpm.	1500rpm.

TABULAR COLUMNS:

Motor			Generator			Armature Cu Loss of Generator	Armature Cu Loss of Motor	Shunt Cu loss of generator
Vm Volts	Im Amps	Ifm Amps	Vg Volts	Ig Amps	Ifg Amps	$(Ig+ Ifg)^2$ Ra Watts	$(Ig+Im-Ifg)^2$ Ra Watts	VgIfg Watts

EXP NO: 6

DATE :

HOPKINSON'S TEST

AIM:

To conduct the Hopkinson's test on the given pair of DC machines and to obtain the performance curve.

APPARATUS REQUIRED:

SL.NO	APPARATUS	RANGE	TYPE	QTY
1	Voltmeter	0 – 600 V	MC	1
2	Voltmeter	0 – 300 V	MC	2
3	Ammeter	0 – 20 A	MC	2
4	Ammeter	0 – 2 A	MC	2
5	Tachometer		Digital	1
6	SPST knife switch			1

PROCEDURE:

1. Connections are made as per the circuit diagram.

2. The supply is switched ON by closing the DPST switch.

3. The motor is started using three point starter.

4. The direction of rotation of the motor is checked if it is proper otherwise the field terminals of the motor are interchanged.

5. The field rheostat of the motor is adjusted till the motor attains its rated speed.

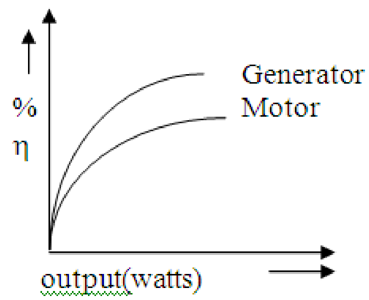
6. The field rheostat of the generator of the generator till the voltmeter connected across the SPST switch reads zero.

7. The SPST switch is closed.

8. The readings of the ammeter and voltmeter are noted and tabulated.

MODEL GRAPH:

1. Output power Vs efficiency (as a motor)
2. Output power Vs efficiency (as a generator)

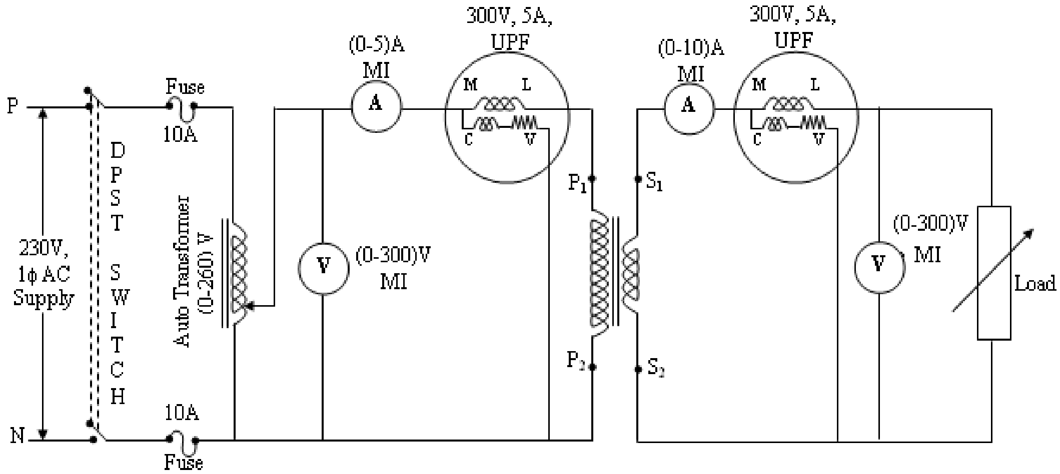


FORMULAE:

1.Armature Cu loss of generator = $(Ifg + Ig)^2$ Ra Watts
2.Armature Cu loss of motor = $(Ig + Im – Ifm)^2$ Ra Watts
3.Shunt Cu loss of generator = Vg Ifg Watts
4.Shunt Cu loss of motor = Vm Ifm Watts
5.Power drawn from supply = Vm Im Watts
6.Stray loss Wc = VmIm – {$(Ifg + Ig)^2$ Ra + $(Ig + Im – Ifm)^2$ Ra + VgIfg + VmIfm} Watts
7.Stray loss of single machine = Wc/2
8.Total loss in generator = Wc/2 + $(Ifg + Ig)^2$ Ra + Vg Ifg Watts
9. Total loss in motor = Vm Ifm + $(Ig + Im – Ifm)^2$ Ra + Wc/2 Watts
10. Output of generator = Vg Ig Watts
11. Input of generator = Output + losses
12. Efficiency of generator = output power/input power * 100 %
13. Input to the motor = Vm (Ig + Im) Wattts
14. Output power of motor = Input – losses Watts
15. Efficiency of motor = Output power/Input power *100%

RESULT:

CIRCUIT DIAGRAM



FUSE RATINGS

NAME PLATE DETAILS:

TABULAR COLUMN:

S.No	Load	Primary			Secondary			Input Power W_1 x MF	Output Power W_2 x MF	Efficiency η %	% Regulation
		V_1 (Volt)	I_1 (Amp)	W_1 (Watt)	V_2 (Volts)	I_2 (Amp)	W_2 (Watt)				

EXP NO: 7**(a)**

DATE:

LOAD TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To conduct load test on single phase transformer and to find efficiency and percentage regulation.

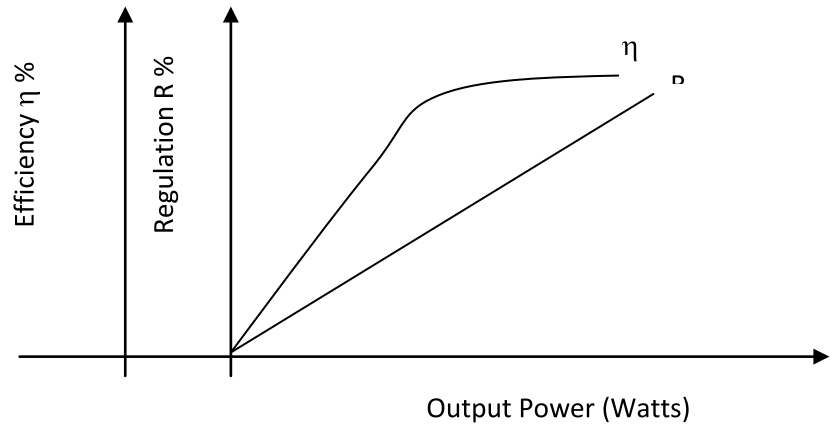
APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-10)A & (0-5) A	MI	2
2	Voltmeter	(0-150)V & (0-300) V	MI	2
3	Wattmeter	(300V, 5A) & (150V, 5A)	Upf	2
4	Auto Transformer	1ϕ, (0-260)V	-	1
5	Resistive Load	5KW, 230V	-	1
6	Connecting Wires	2.5sq.mm	Copper	Few

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. After checking the no load condition, minimum position of auto transformer and DPST switch is closed.
3. Ammeter, Voltmeter and Wattmeter readings on both primary side and secondary side are noted.
4. The load is increased and for each load, Voltmeter, Ammeter and Wattmeter readings on both primary and secondary sides are noted.
5. Again no load condition is obtained and DPST switch is opened.

MODEL GRAPHS:



FORMULAE:

Output Power = W_2 x Multiplication factor

Input Power = W_1 x Multiplication factor

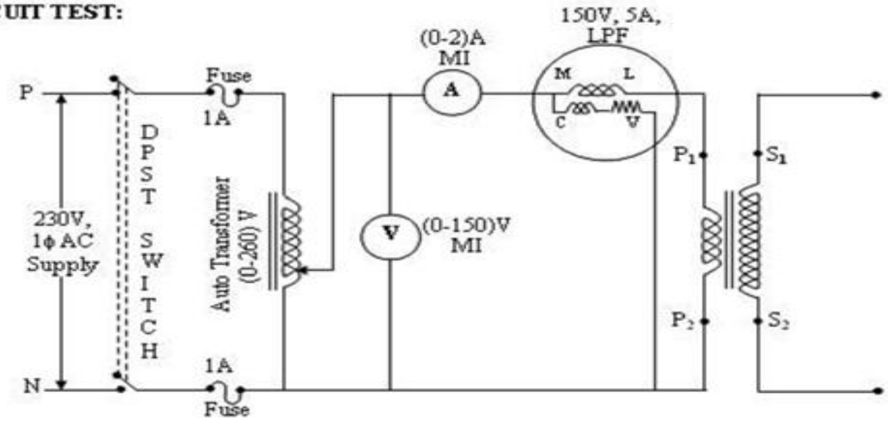
$$\text{Efficiency } \eta\ \% = \frac{\text{Output Power}}{\text{Input Power}} \times 100\%$$

$$\text{Regulation R } \% = \frac{V_{NL} - V_{FL}\ (\text{Secondary})}{V_{NL}} \times 100\%$$

RESULT:

CIRCUIT DIAGRAM:

OPEN CIRCUIT TEST:



FUSE RATING:

10% of rated current

$$\frac{10 \times 5}{100} = 0.5A$$

NAME PLATE DETAILS:

	Primary	Secondary
Rated Voltage :	115V	230V
Rated Current :	10A	5A
Rated Power :	1KVA	1KVA

TABULAR COLUMN

OPEN CIRCUIT TEST:

multiplication factor=

S.NO	Vo(volts)	Io(amps)	Wo(watts)	
			Observed	Actual(mf* Observed)

EXP NO :8

DATE :

OPEN CIRCUIT & SHORT CIRCUIT TEST ON A SINGLE PHASE TRANSFORMER

AIM:

To predetermine the efficiency and regulation of a transformer by conducting open circuit test and short circuit test and to draw equivalent circuit.

APPARATUS REQUIRED:

S.No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-2)A (0-5) A	MI MI	1 1
2	Voltmeter	(0-150)V	MI	2
3	Wattmeter	(150V, 5A) (150V, 5A)	LPF UPF	1 1
4	Connecting Wires	2.5sq.mm	Copper	Few

PROCEDURE:

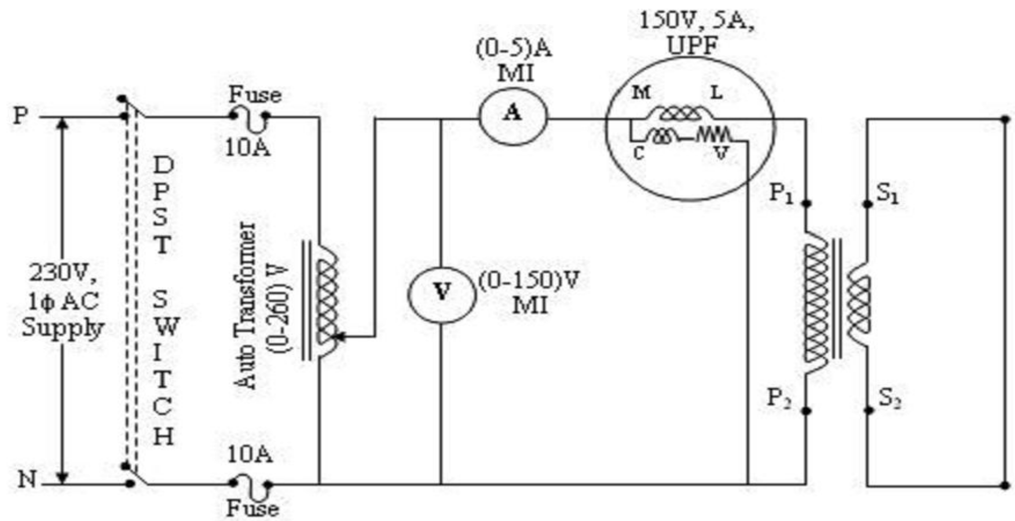
OPEN CIRCUIT TEST:

1. Connections are made as per the circuit diagram.
2. After checking the minimum position of Autotransformer, DPST switch is closed.
3. Auto transformer variac is adjusted get the rated primary voltage.
4. Voltmeter, Ammeter and Wattmeter readings on primary side are noted.
5. Auto transformer is again brought to minimum position and DPST switch is opened.

SHORT CIRCUIT TEST:

1. Connections are made as per the circuit diagram.
2. After checking the minimum position of Autotransformer, DPST switch is closed.
3. Auto transformer variac is adjusted get the rated primary current.
4. Voltmeter, Ammeter and Wattmeter readings on primary side are noted.
5. Auto transformer is again brought to minimum position and DPST switch is opened

SHORT CIRCUIT TEST:



FUSE RATING:

125% of rated current

$$\frac{125 \times 5}{100} = 6.25A$$

NAME PLATE DETAILS:

	Primary	Secondary
Rated Voltage :	230V	115V
Rated Current :	5A	10A
Rated Power :	1KVA	1KVA

SHORT CIRCUIT TEST:

multiplication factor=

S.NO	Vsc(volts)	Isc(amps)	Wsc(watts)	
			Observed	Actual(mf* Observed)

FORMULAE USED:

1. OC Test

$W_0=V_0I_0 \cos \Phi_0$ Where,
$Iw= I_0 \cos \Phi_0$ W_0=no load power R_0 - circuit resistance
$I\mu= I_0 \sin \Phi_0$ I_0 -no load current X_0 - circuit reactance
$R_0=V_0/Iw$ V_0 -no load voltage Cos Φ_0-PF between no load current and voltage
$X_0=V_0/ I\mu$ **Iw -working current component**
Iµ -Magnetizing current component

1. SC Test

$Wsc=Vsc\ Isc \cos \Phi sc$
$R_{01}=Vsc/Isc^2$
$Z_{01}=Vsc/Isc$
X_{01}= square root of Za^2-Ra^2

Wsc= Short circuit power
Vsc =Short circuit voltage
Isc=Short circuit current
R_{01}=Total effective resistance
Z_{01}=total effective impedance

% Regulation

1) % lagging power factor= $Isc\ [R_{01} \cos \Phi_0+X_{01} \sin \Phi_0]*100/V_0$
2) % leading power factor= $Isc\ [R_{01} \cos \Phi_0-X_{01} \sin \Phi_0]*100/V_0$
3)Efficiency=$x*KVA*PF/[x*KVA*PF]+W_0 +x^2\ Vsc$

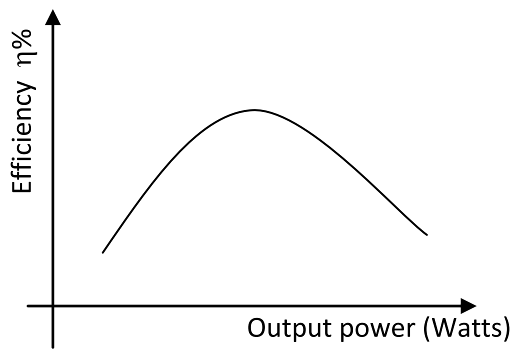
X_{01}=total effective reactance

TABULATION FOR EFFICENCY $I_2=$ $V_2=$

S.NO	LOAD(X)	COS Φ	I/P POWER $P_i = XV_2 I_2 \cos\Phi + W_0 + X^2 W_{SC}$	O/P POWER $P_o = XV_2 I_2 \cos\Phi +$	EFFICENCY $\eta = P_o / P_i$
1	Half load 0.5				
2	Full				

MODEL GRAPHS:

1. Output power Vs efficiency

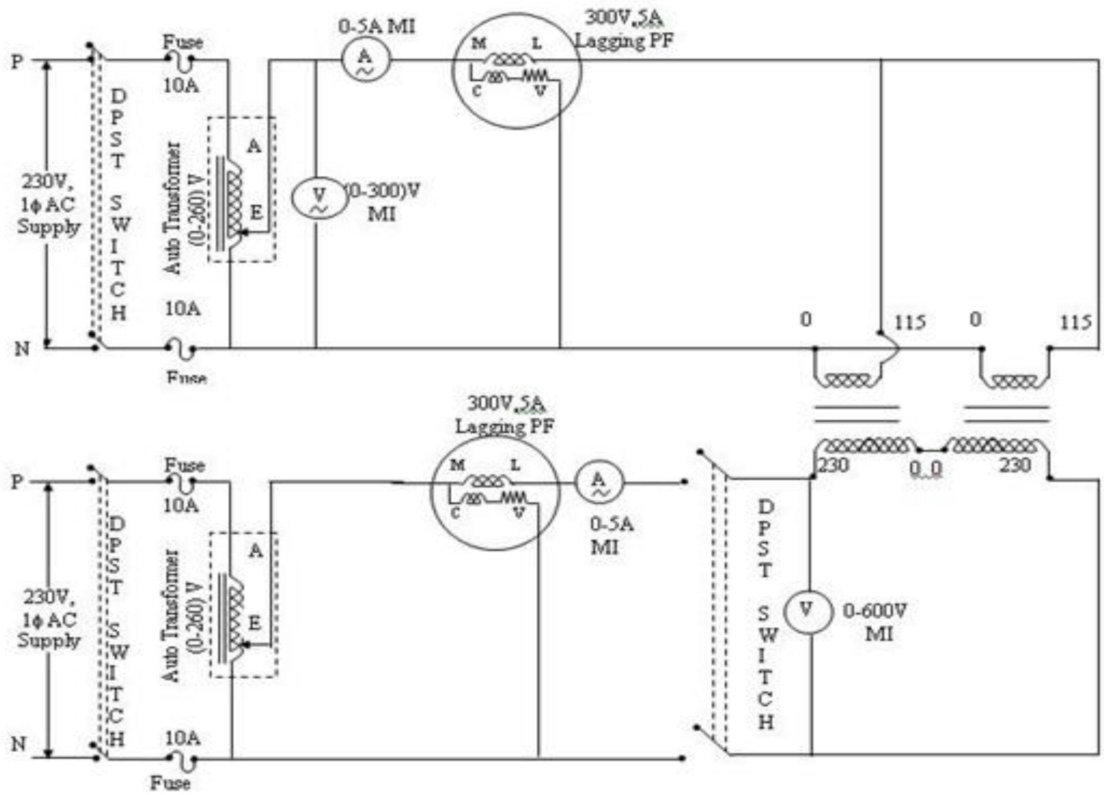


MODEL CALCULATION:

RESULT:

.

CIRCUIT DIAGRAM:



NAME PLATE DETAILS **FUSE RATING**

TABULAR COLUMNS:

TFR.1 Current I_1 A	TFR.2 Current I_2 A	TFR.1 Voltage V_1 V	TFR.2 Voltage V_2 V	TFR.1 W_1 Watts	TFR.2 W_2 Watts

EXP NO : 9

DATE :

SUMPNERS TEST

AIM:

To predetermine the efficiency of the transformer at any desired load and power factor by conducting the Sumpners test.

APPARATUS REQUIRED:

SL.NO.	APPARATUS	TYPE	RANGE	QUANTITY
1.	Ammeter	MI MI	0 – 1 A 0 – 5 A	1 1
2.	Voltmeter	MI MI MI	0 – 300 V 0 – 600 V 0 – 150 V	1 1 1
3.	Wattmeter	LPF UPF	300 V/2.5A 150 V/5A	1 1
4	Transformer	Single phase	1 KVA 230/230 – 115 V	2
5.	Autotransformer	Single phase	230 V/0 – 270 V	2
6.	SPST knife switch			1

PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Adjust the variac of the auto transformer connected to transformer 1 to get the rated voltage.
4. Note down the reading of ammeter, voltmeter & wattmeter of transformer1.
5. Close the SPST switch if the voltmeter connected across the SPST switch reads zero. It not the interchange the terminals of second transformer secondary to get zero reading at SPST switch.
6. Adjust the variac of the auto transformer connected to transformer 2 to get the rated current.
7. Note down the reading of ammeter, voltmeter & wattmeter of transformer2
8. Bring the auto transformer variac to zero position & switch off the supply.

PREDETERMINATION OF EFFICIENCY AT DIFFERENT LOADS

(i) At Unity Power Factor

Load Current I Amps	% of full load X (as decimal fraction)	Core Losses $W_i = W_1/2$ Watts	Copper losses $W_C = W_2 /2 * X^2$ Watts	Total Losses W_i+W_C Watts	Output Power Watts	Input Power Watts	Efficiency η %
	¼ (0.25)						
	½ (0.5)						
	¾ (0.75)						
	1(full load)						

(ii)At 0.8 Power Factor (Lag)

Load Current I Amps	% of full load X (as decimal fraction)	Core Losses $W_i = W_1/2$ Watts	Copper losses $W_C = W_2 /2 * X^2$ Watts	Total Losses W_i+W_C Watts	Output Power Watts	Input Power Watts	Efficiency η %
	¼ (0.25)						
	½ (0.5)						
	¾ (0.75)						
	1(full load)						

FORMULAE:

Core losses Wi=W1/2 Watts

Copper losses, Wc=W2/2*X2(Watts)

Where, X=percentage of Load

Total losses=Wc+Wi Watts

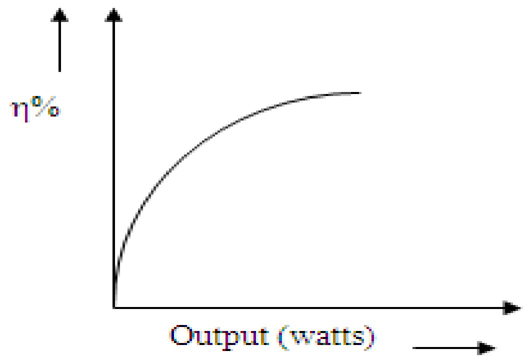
Output power=KVA*100*X*p.f Watts

Input power=Output power+losses Watts

Efficiency=Output/Input*100

GRAPH:

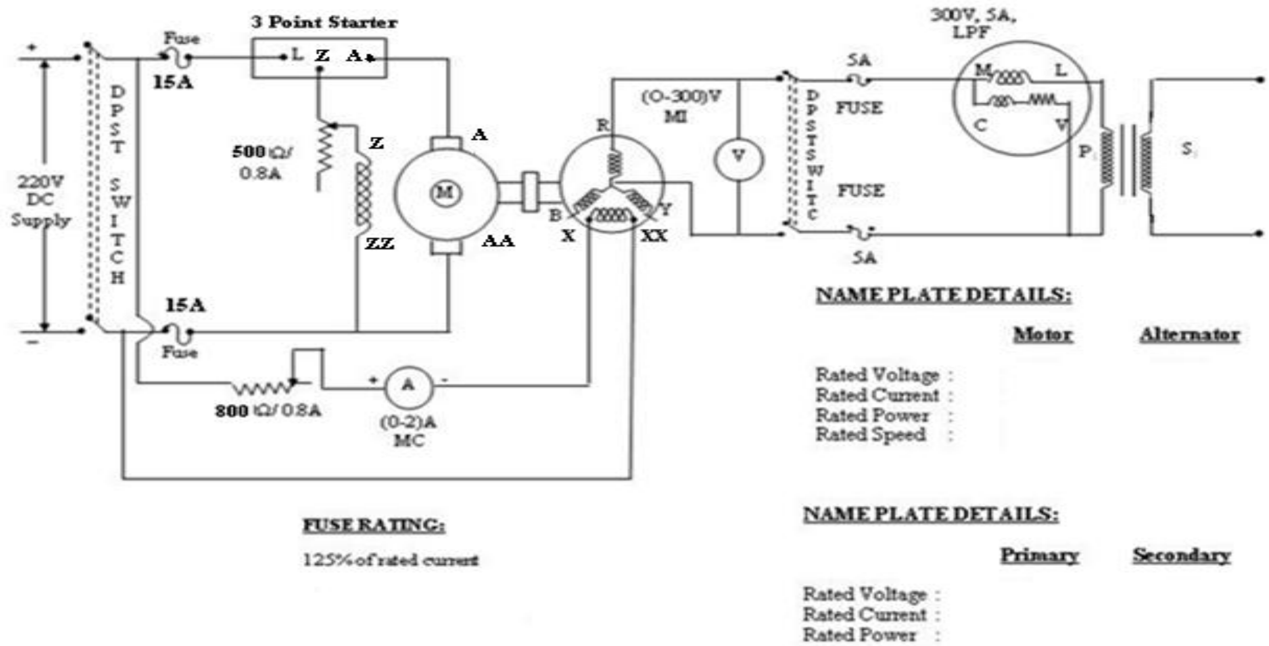
Output power Vs Efficiency at UPF and 0.8 power factor.



MODEL CALCULATION:

RESULT:

CIRCUIT DIAGRAM:



TABULAR COLUMN:

S.N0.	Speed N (rpm)	Frequency f (Hz)	Voltage V (Volts)	Wattmeter reading Watts	W_i / f Joules	$W_h = A * f$	$W_e = B * f^2$	Total Iron loss Wi (Watts) $W_i = W_h + W_e$

EXP NO: 10

DATE:

SEPARATION OF NO LOAD LOSSES IN A SINGLE PHASE TRANSFORMER

AIM:

To separate the eddy current loss and hysteresis loss from the iron loss of single phase transformer.

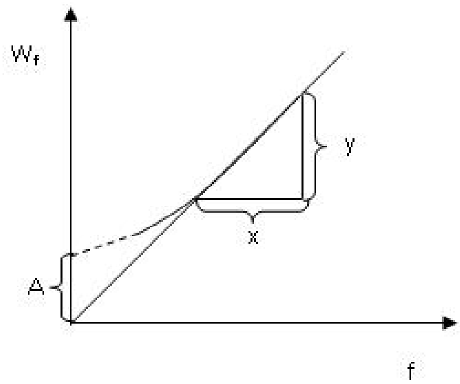
APPARATUS REQUIRED:

S. No.	Name of the Apparatus	Range	Type	Quantity
1	Rheostat	1250Ω , 0.8A	Wire Wound	2
2	Wattmeter	300 V, 5A	LPF	1
3	Ammeter	(0-2) A	MC	1
4	Voltmeter	(0-300) V	MI	1
5	Connecting Wires	2.5sq.mm	Copper	Few

PROCEDURE:

1. Connections are given as per the circuit diagram.
2. Supply is given by closing the DPST switch.
3. The DC motor is started by using the 3 point starter and brought to rated speed by adjusting its field rheostat.
4. By varying the alternator filed rheostat gradually the rated primary voltage is applied to the transformer.
5. The frequency is varied by varying the motor field rheostat and the readings of frequency are noted and the speed is also measured by using the tachometer.
6. The above procedure is repeated for different frequencies and the readings are tabulated.
7. The motor is switched off by opening the DPST switch after bringing all the rheostats to the initial position.

MODELGRAPH:



FORMULA USED:

1. Frequency, $f = (P*N_S) / 120$ in Hz P = No.of Poles & Ns = Synchronous speed in rpm.
2. Hysteresis Loss $W_h = A * f$ in Watts A = Constant (obtained from graph)
3. Eddy Current Loss $W_e = B * f^2$ in Watts B = Constant (slope of the tangent drawn to the curve)
4. Iron Loss $W_i = W_h + W_e$ in Watts

   $W_i / f = A + (B * f)$

   Here the Constant A is distance from the origin to the point where the line cuts the Y- axis in the graph between W_i / f and frequency f. The Constant B is $\Delta(W_i / f) / \Delta f$

MODEL CALCULATION:

RESULT: