Varuvan Vadivelan Institute of Technology

Dharmapuri – 636 703

LAB MANUAL

Regulation : **2013**

Branch : ***B.E*** **- EEE**

Year & Semester : **II Year / IV Semester**

EE6411- ELECTRICAL MACHINES LABORATORY I

ANNA UNIVERSITY- CHENNAI

2013 -REGULATION

EE6411 - ELECTRICAL MACHINES LABORATORY – I

LIST OF EXPERIMENTS:

1. Open circuit and load characteristics of DC shunt generator- critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulativeconnections.
3. Load test on DC shunt and compound motor.
4. Load test on 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 transformers.
8. Open circuit and short circuit tests on single phase transformer.
9. Polarity Test and Sumpner's test on single phase transformers.
10. Separation of no-load losses in single phase transformer.
11. Study of starters and 3-phase transformers connections

TOTAL: 45 PERIODS

SAFETY PRECAUTIONS

PRIMARY RULES:

- Do not make circuit changes or perform any wiring when power is on.
- When in doubt, turn power off.
- Assume that panel jacks on your bench are electrically live unless power is off.
- Be sure you understand the function and wiring of an instrument before using it in a circuit.
- Do not repeat the same mistake.
- Do not wear loose-fitting clothing or jewelry in the lab. Rings and necklaces are usually excellent conductors in excellent contact with your skin.
- It is wise in electrical labs to wear pants rather than shorts or skirts. Ties are also dangerous.
- Powered equipment can be hot! Use caution when handling equipment after it has been operating.

ADDITIONAL KEY PRECAUTIONS:

- Check yourself with disconnect switches, especially those at your bench.
- Work slowly and deliberately. Think as you act.
- Do your wiring, setup, and a careful circuit checkout before applying power.
- Use wires of appropriate length. Do not allow them to drape over your equipment. Avoid splices, which create live surfaces. When running a pair of wires to adjacent terminals, twist the wires together so they do not dangle. This also neatens your work and will save time.
- Keep your bench organized and neat. It should be clear of coats, extra books and papers, and unused equipment.
- Use your bench. Avoid long connections by using the bench transfer wires. Plug instruments into the bench, not into the wall. This gives you the protection of the bench switches.
- Do not touch anything if your hands are wet. The “one-hand” approach is safest.
- Do not pull wires out until you are absolutely sure that the circuit is completely dead. Shocks can occur if an inductive load (motor or transformer) is disconnected while conducting.

ELECTRICAL MACHINES

INTRODUCTION:

The study of electric machinery and electromechanics offers a wide range of opportunities in such diverse areas as manufacturing process control, control systems, electrical energy generation, electromechanical systems and actuators, electric and hybrid transportation, disk drives, electronic power conversion, and others.

Electric machinery and electro mechanics provides an area for the generalist, in that expertise in electromagnetic field theory, circuit analysis, communication principles, information theory, electronics, computers, control systems, and energy areas must come together to create a complete working system. The study of electric machinery is long established within electrical engineering. New technologies and materials, the economics of energy, the use of sophisticated computer hardware and software, and rapid advances in power electronics for energy and motion control offer inviting topics for new engineers.

CLASSIFICATIONS:

In general electrical machines is classified into two types, they are

- Motor
- Generator

Both Motor and generator are three types,

- Shunt
- Series
- Compound

Shunt:

Armature and field winding are in parallel connection

Series:

Armature and field winding are in series connection

Compound:

It is combination of both series and shunt type.

In electrical engineering, electric machine is a general term for electric motors and electric generators. They are electromechanical energy converters.

- **Electric motor:**
  It converts electrical energy into mechanical energy
- **Electric generator:**
  It converts mechanical energy to electrical energy
- **Transformers:**
  It is a static device, which is used to convert voltag

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S.NO	DATE	LIST OF THE EXPERIMENT	SIGNATURE OF THE STAFF	REMARKS
1		Load test on DC shunt motor		
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3		Speed control of DC shunt motor		
4		OCC & load test on separately excited DC generator		
5		OCC & load test on self-excited DC generator		
6		Load test on single phase transformer		
7		OC & SC test on single phase transformer		
8		Swinburne’s test		
9		Separation of iron losses in DC machine		
10		Hopkinson’s test		
11		Sumpner’s test		
12		Study of three phase transformer connections		
13		Load test on DC compound motor		
14		Load test on DC compound generator		

EX.NO. 1	LOAD TEST ON D.C. SHUNT MOTOR
DATE:	

AIM:

To conduct load test on D.C motor and to obtain performance characteristics

APPARATUS REQUIRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Rheostat		230 Ω /1.5A	1
4	Tachometer	Digital	60,000RPM	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- The motor should be started at no load condition.
- The motor should be cooled by circulating water throughout the experiment.

PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPSTswitch.
3. Stat the motor using three point starter.

4.Adjust the field rheostat till the motor reaches its rated speed.

5. Note down the no load reading of voltmeter, ammeter, speed and spring balance reading.
6. Apply load in steps and note down the corresponding reading till the rated current is reached rated value.

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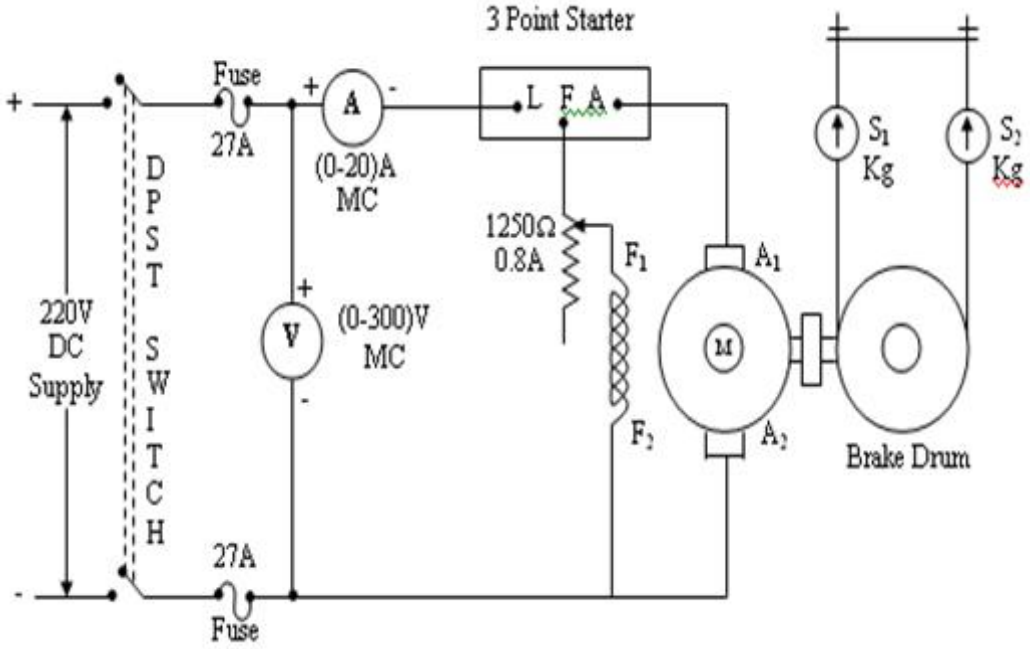
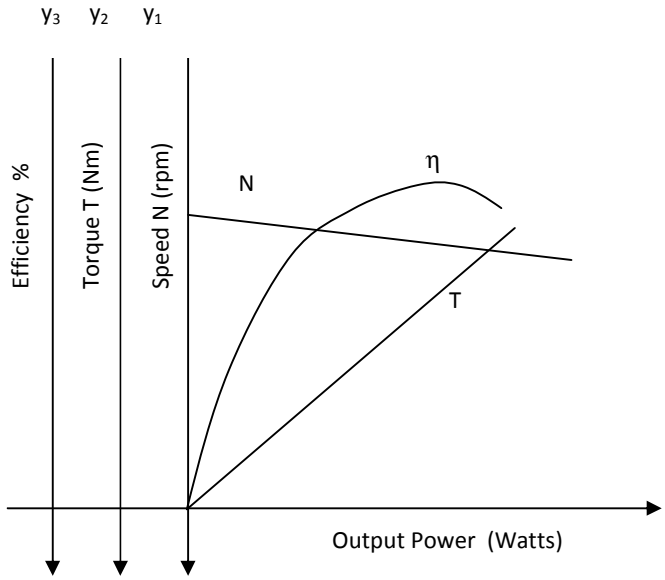
CIRCUIT DIAGRAM (LOAD TEST ON DC SHUNT MOTOR):

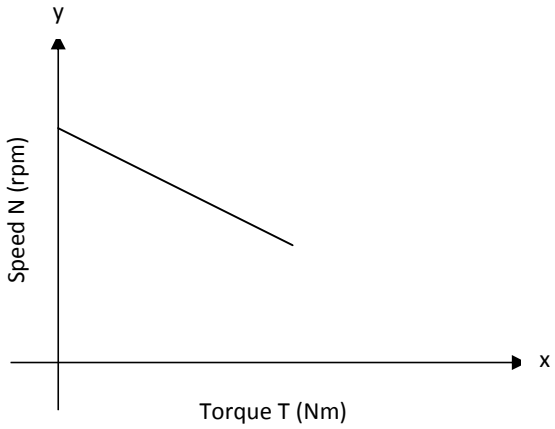


TABULATION: **(LOAD TEST ON D.C. SHUNT MOTOR)**

S. No	Voltage V *volts*	Current I *amps*	Spring balance readings		$S_1 \sim S_2$ *Kg*	Speed N *rpm*	Torque T *Nm*	Input power P_i *watts*	Output Power P_m *watts*	Efficiency ¦ %
			S_1 *Kg*	S_2 *Kg*						

MODEL GRAPHS:





FORMULAE:

- Torque (T) = **9.81(s_1¼s_2)R**
- Output power = **2ΠNT/60**
- Input power = **V*I**

Efficiency , %η=output power/input power * 100

Where,

9.81 = gravity constant

R = radius of brake drum

N = speed in RPM

RESULT:

Thus the load test on DCshunt motor was performed and the performance graphs were drawn.

EX.NO. 2	LOAD TEST ON D.C. SERIES MOTOR
DATE:	

AIM:

To conduct load test on D.C series motor and to obtain performance characteristics

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Tachometer	Digital	60,000RPM	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- The motor should be started at no load condition.
- The motor should be cooled by circulating water throughout the experiment.

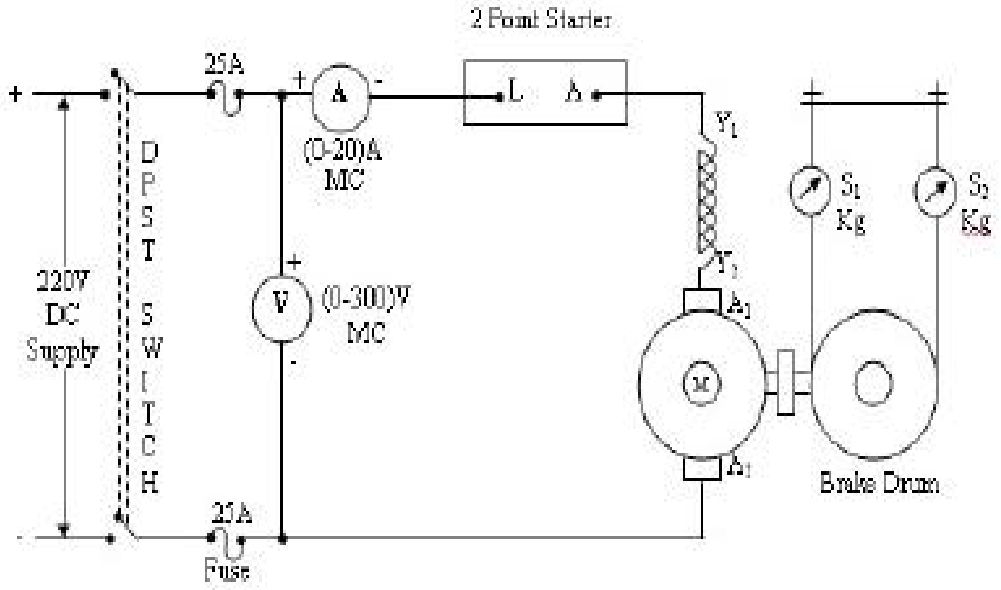
PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Stat the motor using three point starter.

4.Adjust the field rheostat till the motor reaches its rated speed.

5. Note down the no load reading of voltmeter, ammeter, speed and spring balance reading.
6. Apply load in steps and note down the corresponding reading till the rated current is reached rated value.

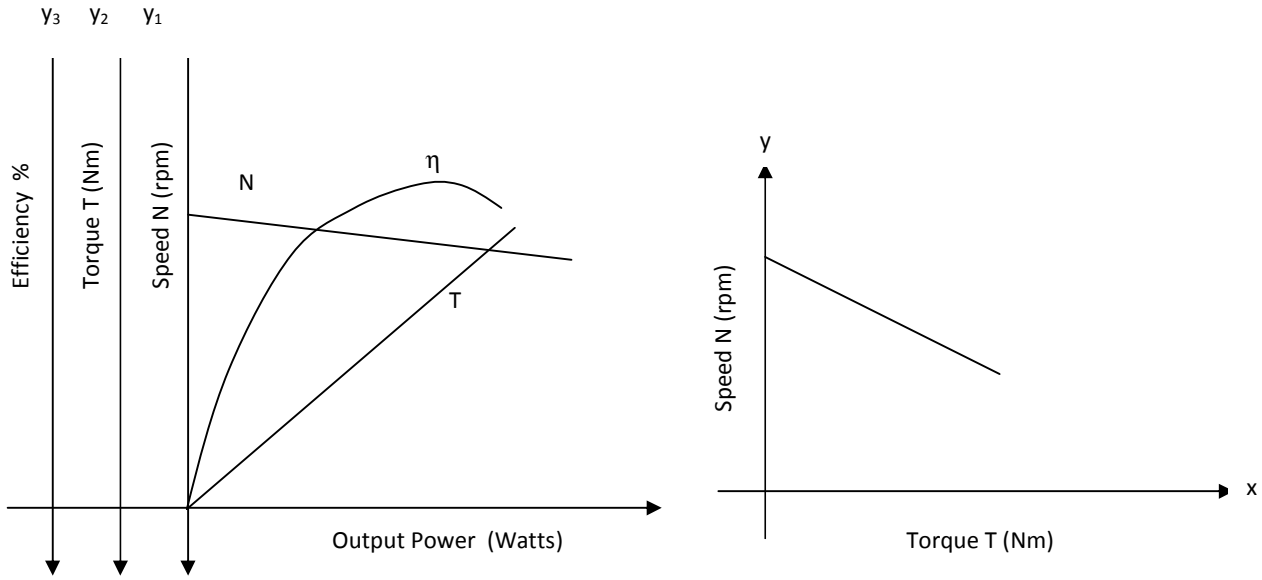
CIRCUIT DIAGRAM (LOAD TEST ON DC SERIES MOTOR):



TABULATION (LOAD TEST ON DC SERIES MOTOR):

S. No	Voltage V *volts*	Current I *amps*	Spring balance readings		$S_1 \sim S_2$ *Kg*	Speed N *rpm*	Torque T *Nm*	Input power P_i *watts*	Output Power P_m *watts*	Efficiency ¦ %
			S_1 *Kg*	S_2 *Kg*						

MODEL GRAPHS:



FORMULAE:

- Torque (T) = **9.81(s1¼s2)R**
- Output power = **2ΠNT/60**
- Input power = **V*I**

Efficiency , %η=output power/input power * 100

Where,

9.81 = gravity constant

R = radius of brake drum

N = speed in RPM

RESULT:

Thus the load test on DC series motor was performed and the performance graphs were drawn.

EX.NO. 3	SPEED CONTROL OF DC SHUNT MOTOR
DATE:	

AIM:

To control the speed of DC shunt motor by Armature control method and Field control method

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Rheostat		1250Ω/0.8A, 50Ω/3.5A	2
4	Tachometer	Digital	60000RPM	1

FUSE RATING:

40% of rated current

PRECAUTIONS:

- Armature rheostat must be kept at maximum resistance position.
- Field rheostat should be kept at minimum resistance minimum position.

PROCEDURE:

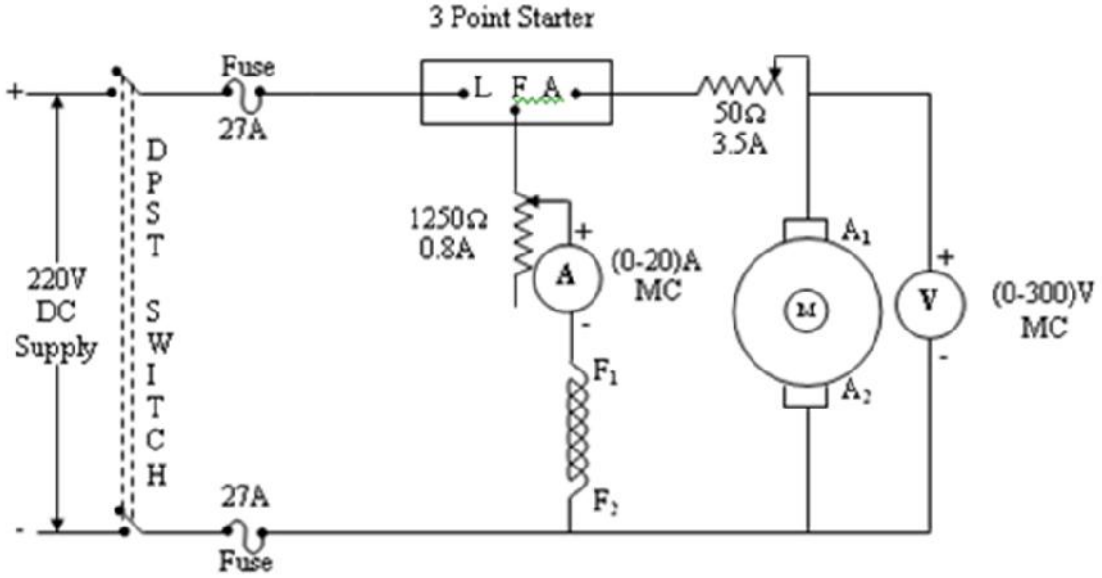
ARMATURE CONTROL METHOD:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the field current(If) as constant value, adjust the armature rheostat and note down the corresponding armature voltage and motor speed.
5. Repeat the step four till the motor reaches the rated speed.

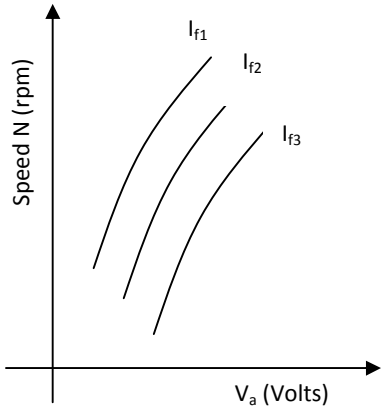
FLUX CONTROL METHOD:

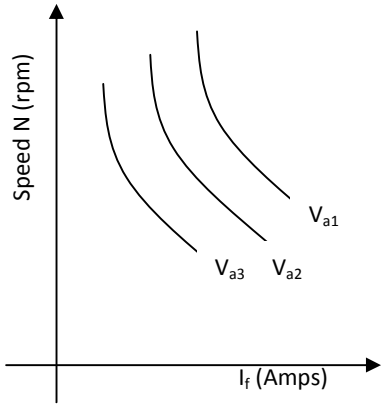
1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the armature voltage as constant value, adjust the field rheostat and note down corresponding field current and motor speed
5. Repeat the step four till the motor reaches the rated speed

CIRCUIT DIAGRAM (SPEED CONTROL DC SHUNT MOTOR):



MODEL GRAPHS:





TABULATION:

ARMATURE CONTROL METHOD:

S.NO	Field current ,I_f =_____A		Field current ,I_f =_____A	
	Armature voltage V_a *volts*	Speed N *RPM*	Armature voltage V_a *volts*	Speed N *RPM*

FIELD CONTROL METHOD:

S.NO	Armature voltage, V_a =_____V		Armature voltage, V_a =_____V	
	Field current I_f *Amps*	Speed N *RPM*	Field current I_f *Amps*	Speed N *RPM*

RESULT:

Thus the speed of DC shunt motor was controlled by Armature control method andField control method and the respective graphs were drawn.

EX.NO. 4	OCC & LOAD TEST ON SEPERATELY EXCITED DC GENERATOR
DATE:	

AIM:

To conduct OCC and load test of a separately excited DC generator and to plot the internal and external characteristics.

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A,(0-2)A	2
3	Rheostat		1250Ω,0.8A	1
4	Tachometer	Digital	60000RPM	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- Field rheostat of motor should be kept at minimum resistance position.
- Field rheostat of generator should be kept at minimum resistance position.

PROCEDURE:

OC TEST:

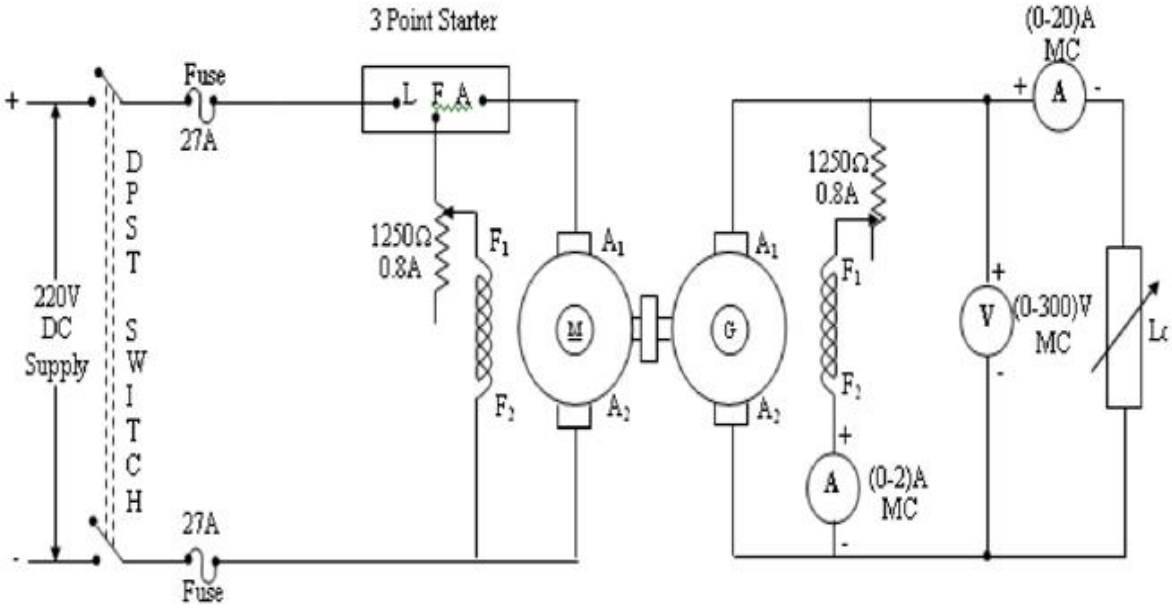
1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the field current (If) as constant value, adjust the armature rheostat and note down the corresponding armature voltage and motor speed.
5. Adjust the potential divider and note down ammeter and voltmeter readings.

LOAD TEST:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the armature voltage as constant value, adjust the field rheostat and note down corresponding field current and motor speed.

5.Adjust the potential divider and note down ammeter and voltmeter readings

CIRCUIT DIAGRAM (SEPARATELY EXCITED DC SHUNT GENERATOR):



TABULATION:

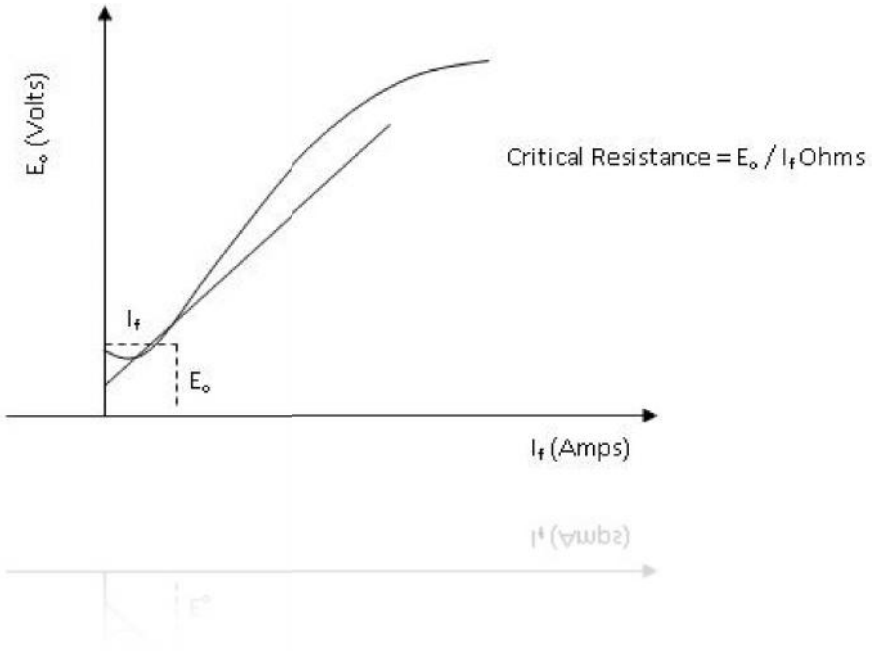
OPEN CIRCUIT CHARACTERISTICS:

S.no	Field current I_f *Amps*	Generated voltage V_a *volts*

LOAD CHARACTERISTICS:

S.no	Load current I_L *Amps*	Load voltage V_L *Volts*	Armature current $I_a = I_L$ *Amps*	Power I_aR_a *watts*	Generated voltage $E_g = V_L + I_aR_a$ *Volts*

MODEL GRAPH:



RESULT:

Thus an OC and LOAD characteristics of a separately excited generator was performed and the respective graphs were drawn.

EX.NO. 5	OCC & LOAD TEST ON SELF EXCITED DC GENERATOR
DATE:	

AIM:

To conduct OCC and load test of a self excited DC generator and to plot the internal and external characteristics.

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A,(0-2)A	2
3	Rheostat		1250Ω,0.8A	1
4	Tachometer	Digital	60000RPM	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- Field rheostat of motor should be kept at minimum resistance position.
- Field rheostat of generator should be kept at minimum resistance position.

PROCEDURE

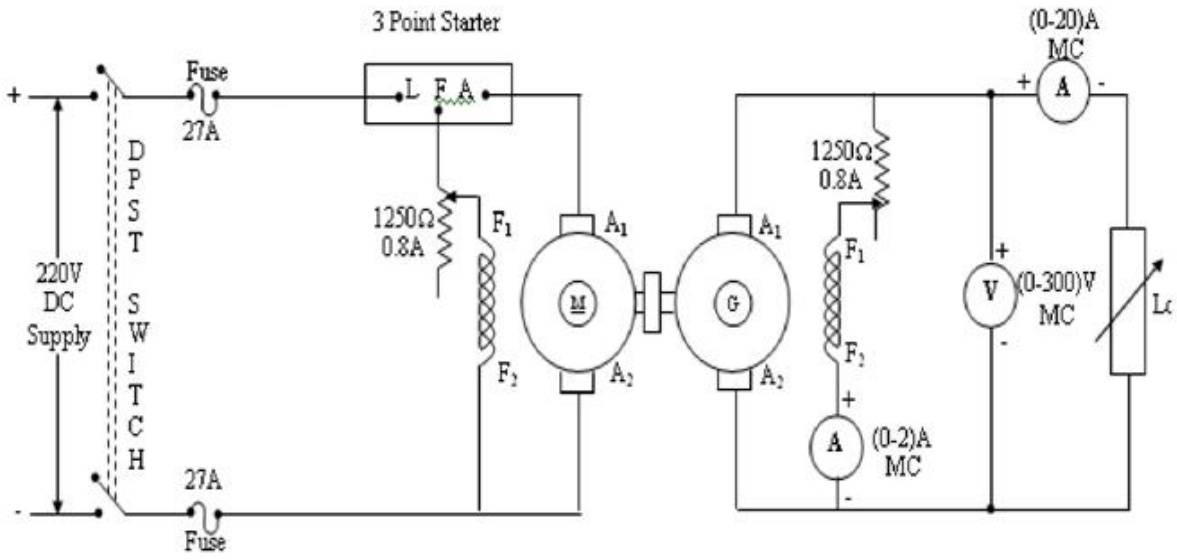
OC TEST:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the field current (If) as constant value, adjust the armature rheostat and note down the corresponding armature voltage and motor speed.
5. Adjust the potential divider and note down ammeter and voltmeter readings.

LOAD TEST:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using three point starter.
4. By keeping the armature voltage as constant value, adjust the field rheostat and note down corresponding field current and motor speed.
5. Adjust the potential divider and note down ammeter and voltmeter readings

CIRCUIT DIAGRAM (SELF EXCITED DC SHUNT GENERATOR):



TABULAR COLUMN:

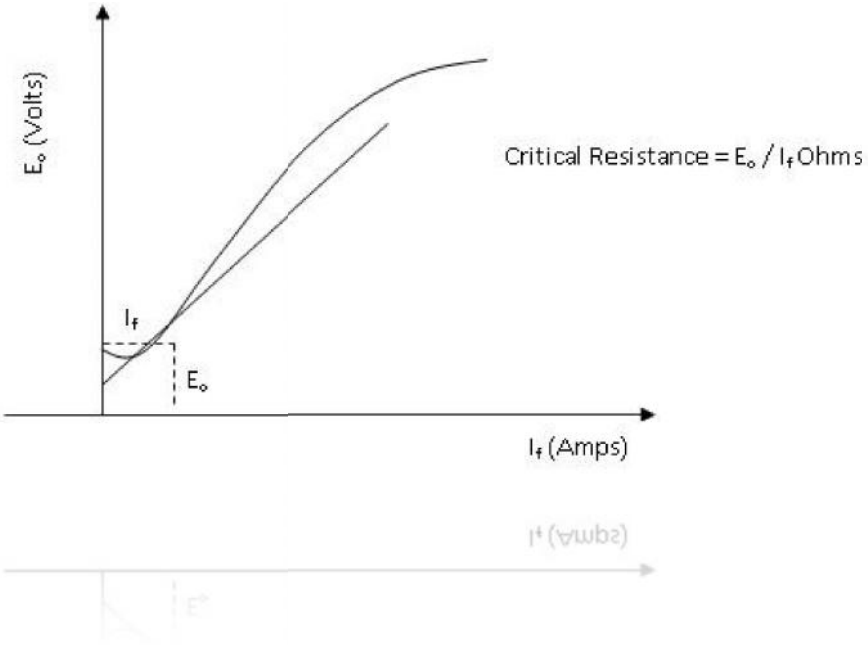
OPEN CIRCUIT CHARACTERISTICS:

S.no	Field current I_f *Amps*	Generated voltage V_a *volts*

LOAD CHARACTERISTICS:

S.no	Load current I_L *Amps*	Load voltage V_L *Volts*	Armature current $I_{a=}\ I_L$ *Amps*	Power I_aR_a *watts*	Generated voltage $E_g = V_L + I_aR_a$ *Volts*

MODEL GRAPH:



RESULT:

The direct load test on the given self-excited DC generator has been conducted and the internal & external characteristics are plotted.

EX.NO. 6	LOAD TEST ON SINGLE PHASE TRANSFORMER
DATE:	

AIM:

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

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	Voltmeter	MI	(0-300)V	2
2	Ammeter	MI	(0-20)A	2
3	Wattmeter	UPF	0-300 V/5A	2
4	Single phase transformer		1 KVA,230/115 V	1
5	Auto transformer		230V/0- 270 V	1
6	Load			1

FUSE RATING:

125% of rated current

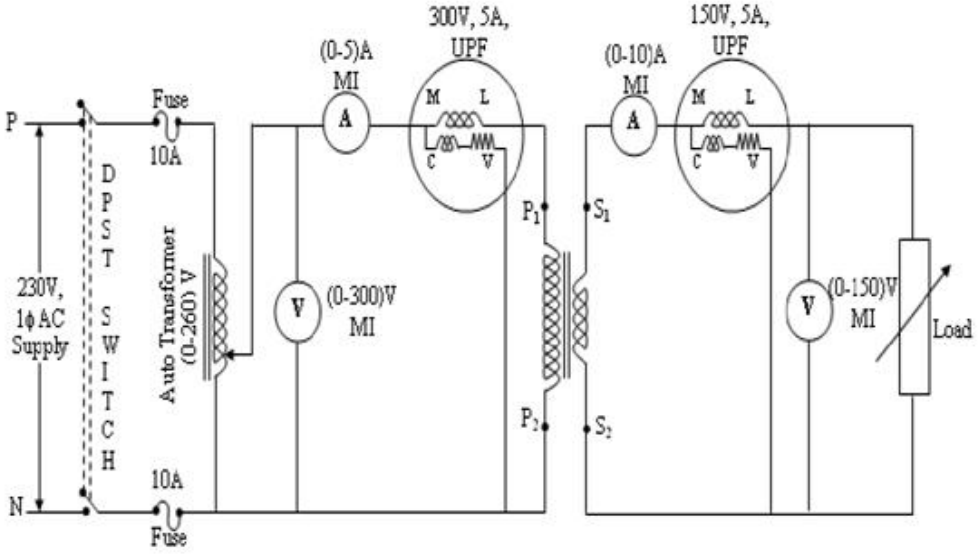
PRECAUTIONS:

- The autotransformer should be kept at minimum voltage position.
- Before switching off the supply the variac should be brought back to0 minimum voltage position.

PROCEDURE

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using auto transformer starter.
4. Note down the readings of primary and secondary side.
5. Repeat the procedure until it reaches rated current value.

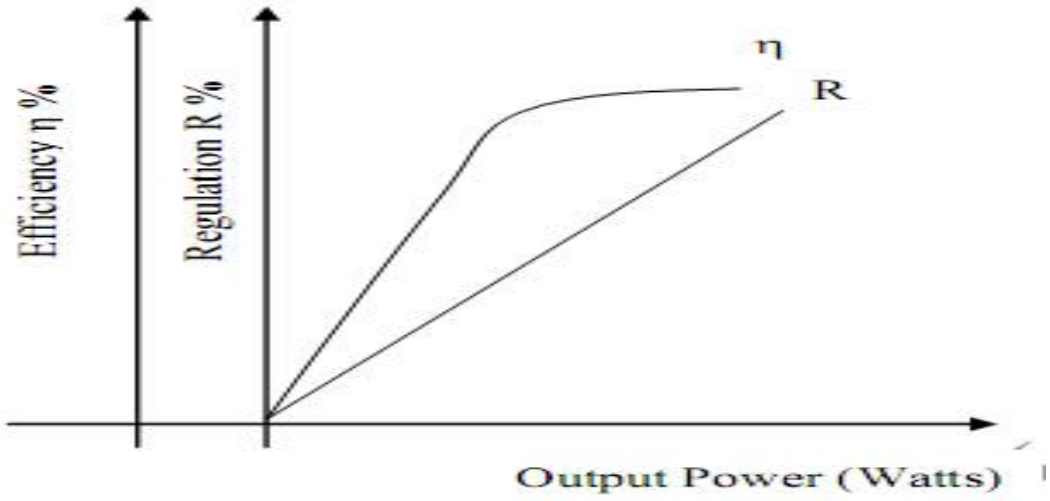
CIRCUIT DIAGRAM (LOAD TEST ON SINGLE PHASE TRANSFORMER):



TABULATION: (LOAD TEST ON SINGLE PHASE TRANSFORMER)

S.NO	Load	Primary side			Secondary side			Inpur power W_1X MF	Inpur power W_2X MF	Output power=V*I	Efficiency	Regulation
		V_1 *Volt*	I_1 *Amp*	W_1 *Watt*	V_2 *Volt*	I_2 *Amp*	W_2 *Watt*	*Watt*	*Watt*	*Watt*	%	%

MODEL GRAPHS:



FORMULAE:

Efficiency,% ŋ = output power/input power * 100

- Output power = **V*I**
- Input power = $\mathbf{W_1 + W_2}$

RESULT:

Thus the load test on single phase transformer was performed and the respective graph were plotted.

EX.NO. 7	OPEN CIRCUIT AND SHORT CIRCUIT TESTS ON SINGLE PHASE TRANSFORMER
DATE:	

AIM:

To conduct OC and SC test on a single phase transformer ant to obtain percentage regulation and efficiency.

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	Voltmeter	MI	(0-300)V,(0-150)V	Each 1
2	Ammeter	MI	(0-20)A,(0-5)A	Each 1
3	Wattmeter	LPF	0-300 V/5A	2
4	Single phase transformer		1 KVA,230/115 V	1
5	Auto transformer		230V/0- 270 V	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- The autotransformer should be kept at minimum voltage position.
- Before switching off the supply the variac should be brought back to0 minimum voltage position.

PROCEDURE

OC TEST:

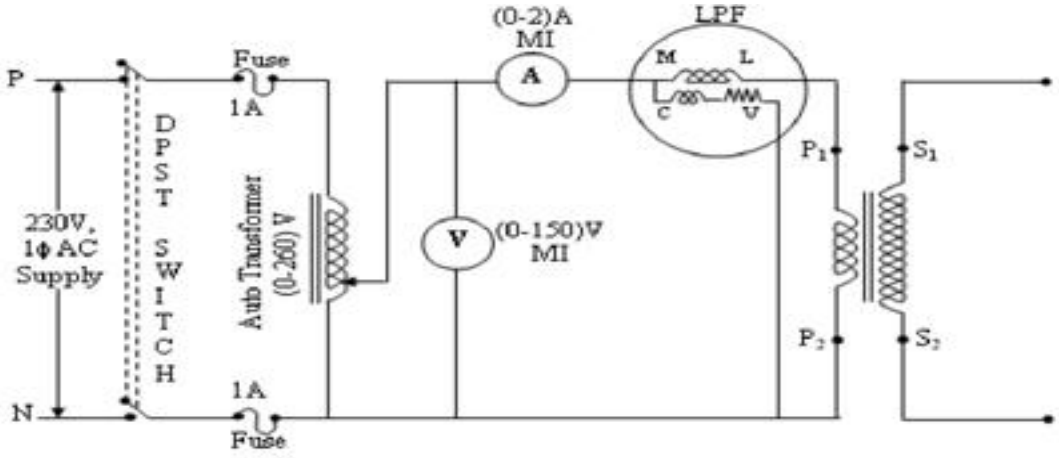
1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using auto transformer starter.
4. Note down the readings of voltmeter, ammeter and wattmeter at no load condition.

SC TEST:

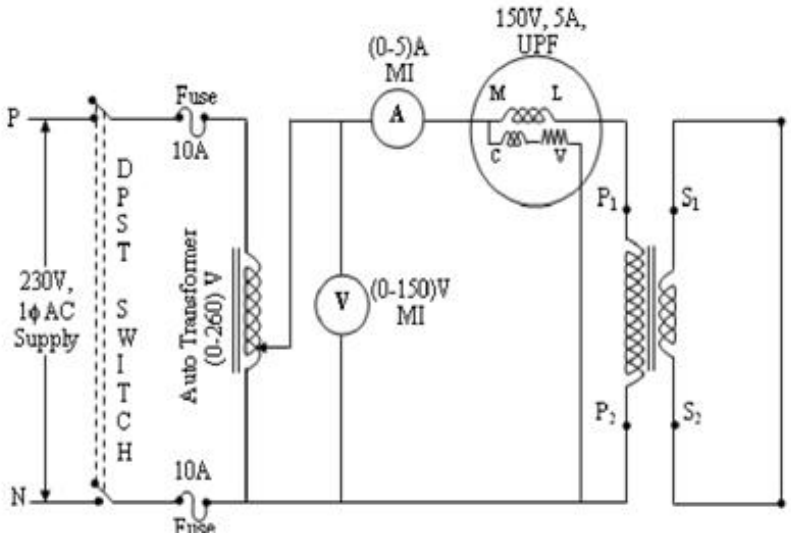
1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start the motor using auto transformer starter.
4. Note down the readings of voltmeter, ammeter and wattmeter at short circuit condition.

CIRCUIT DIAGRAM:

OPEN CIRCUIT TEST:



SHORT CIRCUIT TEST:



TABULATIONS:

OPEN CIRCUIT TEST:

Voltage V_O *volts*	Current I_O *amps*	Wattmeter reading	
		Observed W_O *watts*	Actual= W_O*mf *watts*

SHOET CIRCUIT TEST:

Voltage V_{SC} *volts*	Current I_{SC} *amps*	Wattmeter reading	
		Observed W_{SC} *watts*	Actual= W_{SC}*mf *watts*

Where,

mf = multiplication factor

PREDETERMINATION OF EFFICIENCY AT DIFFERENT POWER FACTORS:

S.No	Load current I_f *Amps*	load X *%*	Input losses $W_o=W_O*mf$ *watts*	Core losses $W_c=X^2W_{SC*}mf$ *watts*	Total loss= $W_i+ W_c$ *watts*	o/p power *watts*	i/p power *watts*	Efficiency η *%*
		25						
		50						
		75						
		100						

FORMULAE:

1. No load resistance $R_0 = V_1/I_W$,
2. No load reactance $X_0 = V_1 / I\mu$
3. Active current $I_W = I_0 \cos \phi_0$
4. Reactive current $I\mu = I_0 \sin\phi_0$
5. Primary impedance $Z_{01} = V_{SC}/I_{SC}$
6. Primary resistance $R_{O1}=W_{SC}/I_{SC}^2$
7. % Regulation at lead = $I_{SC}(R_{O1}\cos\phi_0 + X_{O1} \sin \phi_0)/V_1$
8. % Regulation at lead= $I_{SC}(R_{O1}\cos\phi_0 + X_{O1} \sin \phi_0)/V_1$
9. Copper Losses = $W_{SC} * X^2$
10. Output power = KVA*1000*X *PF watts
11. Input power = Output power + Losses

. Efficiency ,%ŋ= output power / input power* 100

- X= fraction of load
- PF= power factor
- Mf=multiplication factor

RESULT:

Thus the OC & SC test on single phase transformer was performed and the respective graphs were drawn.

EX.NO. 8	SWINBURNE'S TEST
DATE:	

AIM:

To predetermine the efficiency of a DC shunt machine by conducting the Swinburne's Test as a motor and generator.

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Rheostat		1250Ω/0.8A	1
4	Tachometer	Digital	60000RPM	1

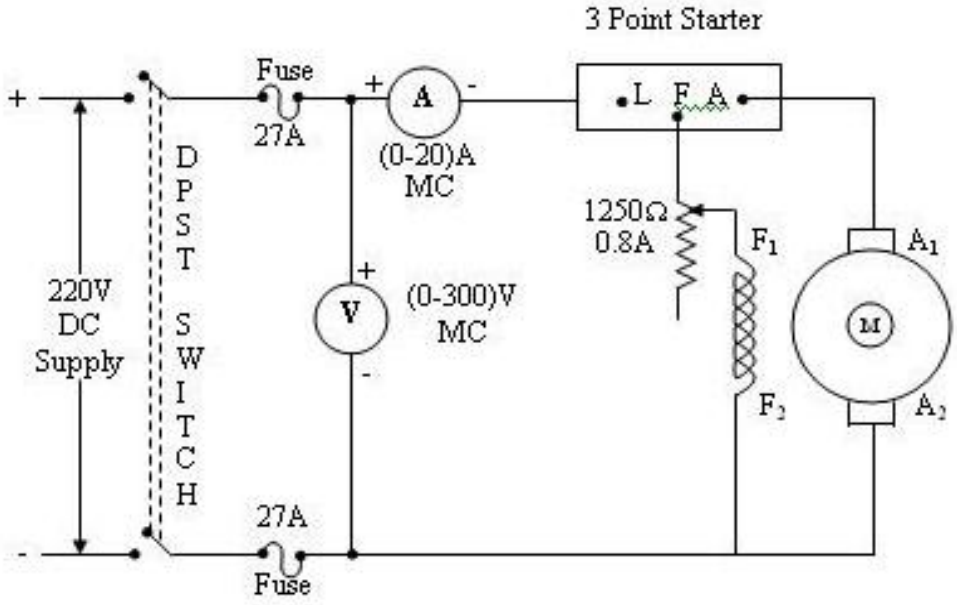
FUSE RATING:

Fuse rating = 40% of rated current

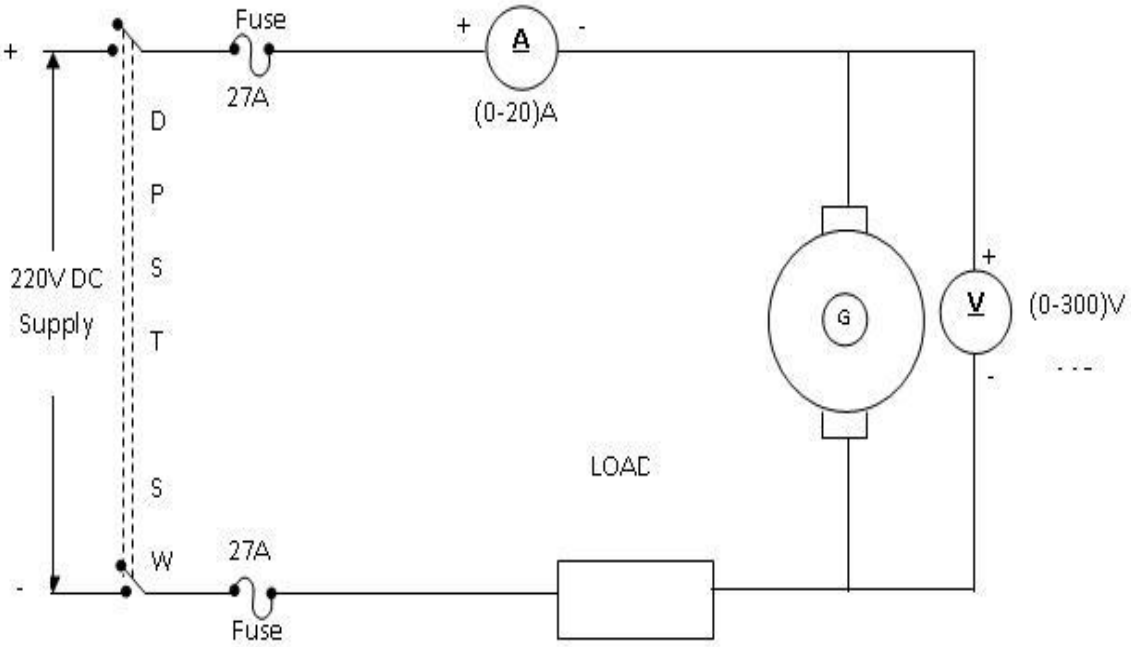
PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPSTswitch.
3. Stat the motor using three point starter.
4. Adjust the field rheostat till the motor reaches its rated speed.
5. Note down the no load reading of voltmeter, ammeter and speed values.

CIRCUIT DIAGRAM (SWINBURENE'S TEST):



CIRCUIT DIAGRAM (MEASUREMENT OF ARMATURE RESISTANCE):



TABULAR COLUMNS:

MOTO ON NO LOAD:

V_O *Volts*	I_O *Amps*	I_f *Amps*	$I_a = I_O - I_f$ *Amps*	**Speed N** *RPM*

TO FIND ARMATURE RESISTANCE:

S.NO	Armature Voltage V_a *Volts*	Armature Current I_a *Amps*	Armature Resistance R_a Ω

PREDETERMINATION OF EFFICIENCY AT DIFFERENT LOADS:

S.NO	Load current I_f *Amps*	load X *%*	Input losses $W_o=W_O*mf$ *watts*	Core losses $W_c=X^2W_{SC*}mf$ *watts*	Total loss $W_i+ W_c$ *watts*	o/p power *watts*	i/p power *watts*	Efficiency η *%*
		25						
		50						
		75						
		100						

FORMULAE:

Efficiency % = output power/input power * 100

- Output power = **input power – losses,watts**
- Input power = **V* I,watts**

RESULT:

Thus the swinburne's test is conducted on a DC shunt motor to predetermine its efficiency as a motor and generator.

EX.NO. 9	SEPARATION OF IRON LOSSES IN DC MACHINE
DATE:	

AIM:

To separate the no load losses in a DC Machine as iron losses and mechanical losses.

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V	1
2	Ammeter	MC	(0-20)A	1
3	Rheostat		1250Ω/0.8A	1
4	Tachometer	Digital	60000RPM	1

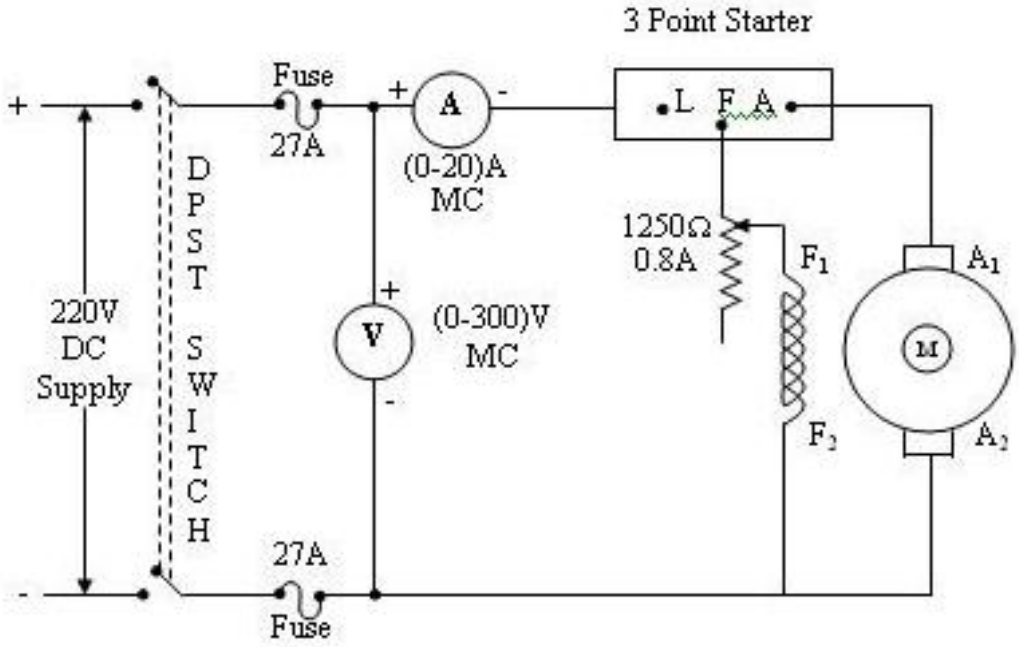
FUSE RATING:

Fuse rating = 40% of rated current

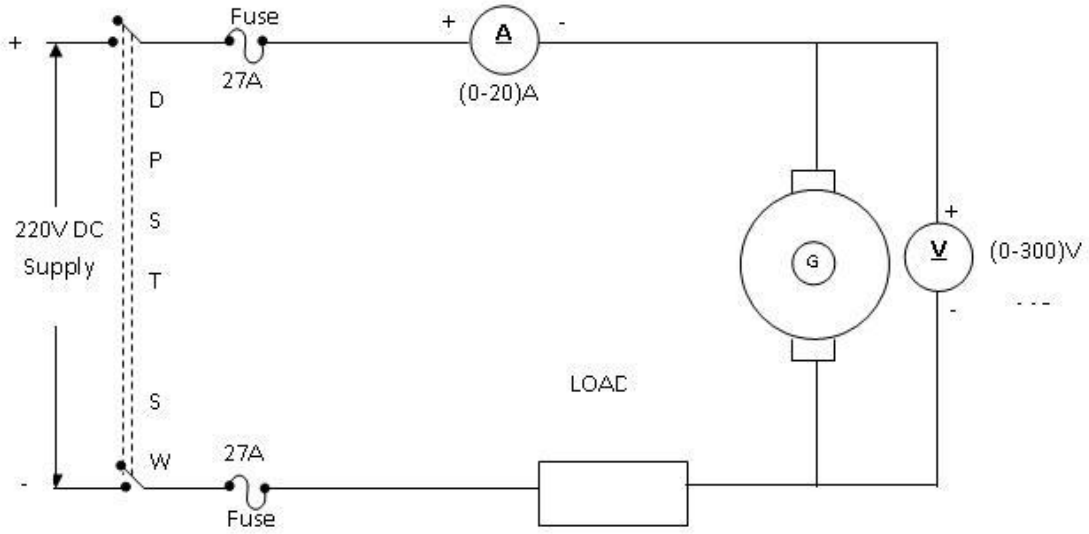
PROCEDURE:

1. Connections are made as per the circuit diagram.
2. The DC supply is switched ON and the motor is started using 3-point starter.
3. The armature rheostat is adjusted from maximum position to obtain the rated voltage.
4. The field rheostat is adjusted to obtain the rated speed.
5. The readings of the voltmeter and ammeter are noted.
6. By varying the armature rheostat the voltage is gradually reduced till the current becomes almost constant. The readings of the voltmeter and the ammeter are noted in the tabular column.
7. The armature resistance (Ra) is determined by voltmeter – ammeter method by giving low voltage DC supply.
8. The armature copper loss is calculated and hence the constant losses are obtained.
9. A graph is drawn with constant losses along Y-axis and no load voltage along the X- axis.
10. The mechanical loss is found from the graph hence the iron losses are determined.

CIRCUIT DIAGRAM(SEPARATION OF IRON LOSSES);



CIRCUITDIAGRAM (MEASUREMENT OF ARMATURE RESISTANCE):



TABULAR COLUMNS:

TO FIND ARMATURE RESISTANCE:

S.NO	Armature Voltage V_a *Volts*	Armature Current I_a *Amps*	Armature Resistance R_a Ω

SEPARATION OF IRON LOSSES:

Mechanical loss, W_m = _____watts

s.no	No load voltage V_o *volts*	No load current I_o *amps*	No load power W_o *watts*	Field current I_f *amps*	Armature current I_a *amps*	Armature cu loss $I_a^2R_a$ *watts*	Constant loss $W_c=W_oI_a^2R_a$ *watts*	Iron loss $W_i= W_cW_m$ *watts*

FORMULAE:

1. No load input power Wo = **VoIo watts**
2. Armature current Ia = **Io – I_f Amps**
3. Armature copper loss = **Ia^2Ra Watts**
4. Constant losses W_C = **V_aI_a- Ia^2Ra**
5. Mechanical loss = **W_m(from the graph**)

Core or iron losses is given as

$$W_i = W_c - W_m \text{watts}$$

RESULT:

Thus the total no load losses in a DC machine have been separated as iron losses and mechanical loss.

EX.NO. 10	HOPKINSON'S TEST
DATE:	

AIM:

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

APPARATUS REQUIRRED:

S. No.	Apparatus	Type	Range	Quantity
1	Voltmeter	MC	(0-300)V,(0-600)V	Each 1
2	Ammeter	MC	(0-20)A,(0-5)A	2,1
3	Rheostat		1250Ω/0.8A	2
4	Tachometer	Digital	60000RPM	1

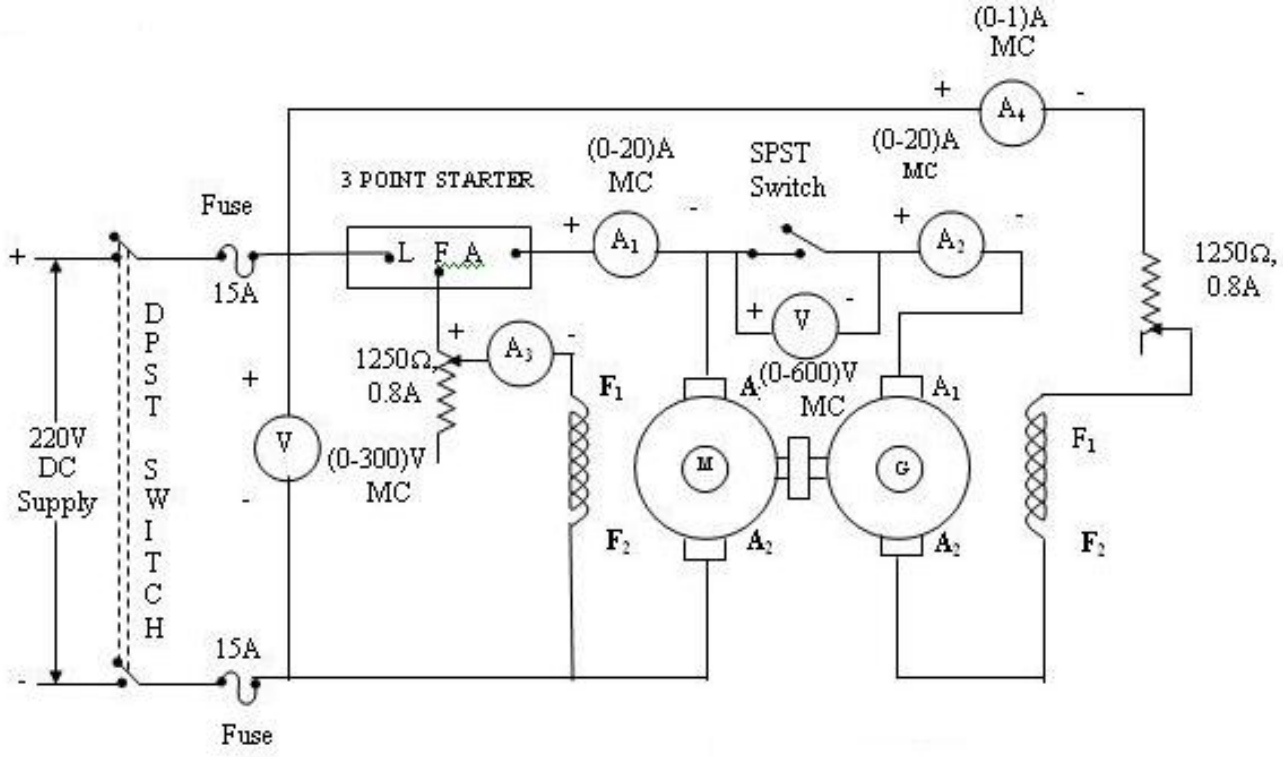
FUSE RATING:

Fuse rating = 40% of rated current

PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPSTswitch.
3. Stat the motor using three point starter.
4. Adjust the field rheostat till the motor reaches its rated speed.
5. Note down the no load reading of voltmeter, ammeter and speed values from both motor and generator.

CIRCUIT DIAGRAM (HOPKINSON'S TEST):



TABULATION(HOPKINSON'S TEST)

Motor			Generator			Armature Cu Loss of Generator	Armature Cu Loss of Motor	Shunt Cu loss of generator
V_m *Volts*	I_m *Amps*	If_m *Amps*	V_g *Volts*	I_g *Amps*	If_g *Amps*	$(I_g+If_g)^2 R_g$ *Watts*	$(I_g+I_m-If_g)^2$ Ra *Watts*	$V_g If_g$ *Watts*

FORMULAE:

1. Armature Cu loss of generator = $(\mathbf{Ifg + Ig})^2$ **Ra Watts**
2. Armature Cu loss of motor = $\mathbf{(Ig + Im – Ifm)^2}$ **Ra Watts**
3. Shunt Cu loss of generator = **Vg Ifg Watts**
4. Shunt Cu loss of motor = **VmIfm Watts**
5. Power drawn from supply = **VmIm Watts**
6. Stray loss

   Wc = $\mathbf{VmIm – \{(Ifg + Ig)^2 Ra + (Ig + Im – Ifm)^2 Ra + VgIfg + VmIfm\}}$ **Watts**

7. Stray loss of single machine = **Wc/2**
8. Total loss in generator = $\mathbf{Wc/2 + (Ifg + Ig)^2 Ra + Vg\ Ifg}$ **Watts**
9. Total loss in motor = $\mathbf{VmIfm + (Ig + Im – Ifm)^2 Ra + Wc/2}$
10. Output of generator = **Vg Ig Watts**
11. Input of generator = **Output + losses**

Efficiency of generator = output power/input power * 100 %

12. Input to the motor = **Vm (Ig + Im) Wattts**
13. Output power of motor = **Input – losses Watts**

Efficiency of motor = Output power/Input power *100%

Ifg - generator field current
Ifm - motor field current
Ig - generator armature current
Im - motor armature current

RESULT

Thus the hopkinson' s test is conducted to predetermine its efficiency from motor and generator set.

EX.NO. 11	SUMPNER'S TEST
DATE:	

AIM:

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

APPARATUS REQUIRED:

S.NO	APPARATUS	TYPE	RANGE	QUANTITY
1	Voltmeter	MI	(0-300)V,(0-600)V	Each 1
2	Ammeter	MI	(0-5)A	Each 1
3	Wattmeter	LPF	0-300 V/5A	2
4	Single phase transformer		1 KVA,230/115 V	2
5	Auto transformer		230V/0- 270 V	2

FUSE RATING:

Fuse rating = KVA* 1000/rated voltage.

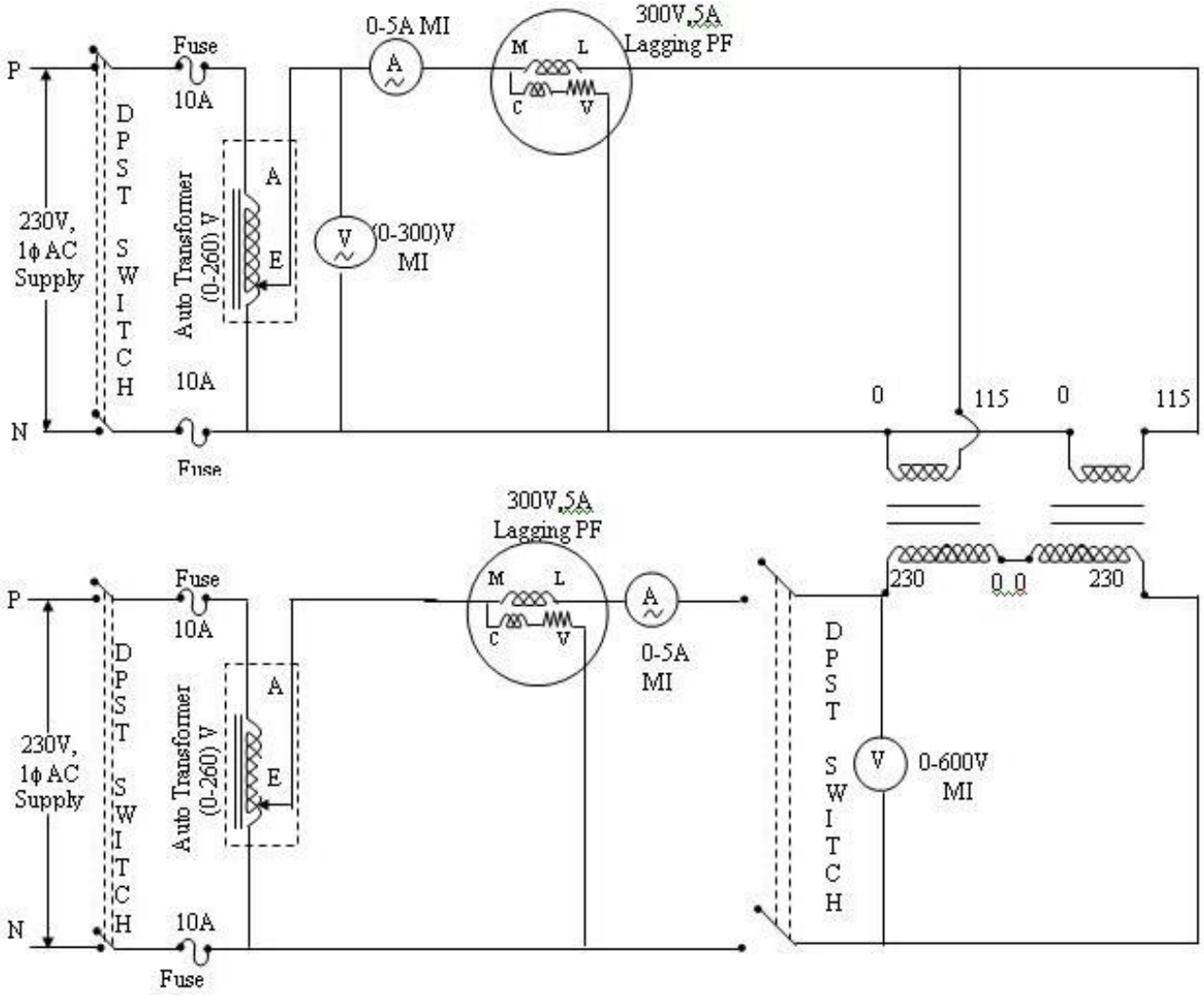
PRECAUTIONS:

- The autotransformer should be kept at minimum voltage position.
- Before switching off the supply the variac should be brought back to0 minimum voltage position

PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPST switch.
3. Start by using auto transformer starter.
4. Note down the readings of primary and secondary side of both the transformers.

CIRCUIT DIAGRAM(SUMPNER'S TEST):



TABULATION (sumpner's test):

Transformer 1			Transformer 2		
Current I_1 ***amps***	**Voltage V_1** ***volts***	**Power W_1** ***watts***	**Current I_2** ***amps***	**Voltage V_2** ***volts***	**Power W_2** ***watts***

PREDETERMINATION OF EFFICIENCY AT DIFFERENT LOADS:

S.NO	Load current I_L *Amps*	load X *%*	Core losses $W_i = W_i/2$ *watts*	Core losses $W_c = X^2 * W_2/2$ *watts*	Total loss $W_i + W_c$ *watts*	o/p power *watts*	i/p power *watts*	Efficiency η *%*
1		**25**						
2		**50**						
3		**75**						
4		**100**						

FORMULAE:

1. Core loss W_i = $W_1/2$
2. Copper loss W_c = $W_2/2*X^2$
3. Total losses = $W_c + W_i$
4. output power = **KVA*100*X*PF**
5. Input power = **output power + losses**

Efficiency= output power/input power*100

RESULT:

Thus the sumpner's test is conducted on a back to back transformer to predetermine its efficiency .

EX.NO. 12	STUDY OF THREE PHASE TRANSFORMER CONNECTIONS
DATE:	

AIM:

To conduct the three phase transformer in various modes and to obtain the voltage current relations.

APPARATUS REQUIRED:

S.NO	APPARATUS	RANGE	TYPE	QUANTITY
1	Voltmeter	(0-600)V	MI	2
2	Voltmeter	(0-300)V	MI	2
3	Ammeter	(0-10)A	MI	2
4	Ammeter	(0-5)A	MI	2
5	3 phasetransformer	415/470V		1
6	3Phase auto transformer	415/(0-470)V		1
7	3 Phase load	5KW		**1**

THEORY:

STAR/STAR (OR) Y/Y CONNECTION:

This connection is for high voltage transformer. The phase voltage $1/\sqrt{3}$ of line voltage. The ratio of line voltage is 1/3 1°&2° signs is the same as the transformer ratio of each transformer. The phase shift of 30 b/w the phase voltage and line voltage both on primary and secondary side. This connection works only if the load is balanced with the unbalanced load.

DELTA/DELTA OR Δ/Δ CONNECTION:

This connection is for low voltage transformer. The ratio of transformation between primary and secondary line voltage is exactly as same as that of each transformer. There is an angular displacement between primary and secondary voltages. Moreover, there is no internal phase shift between phase and line voltage on the other side.

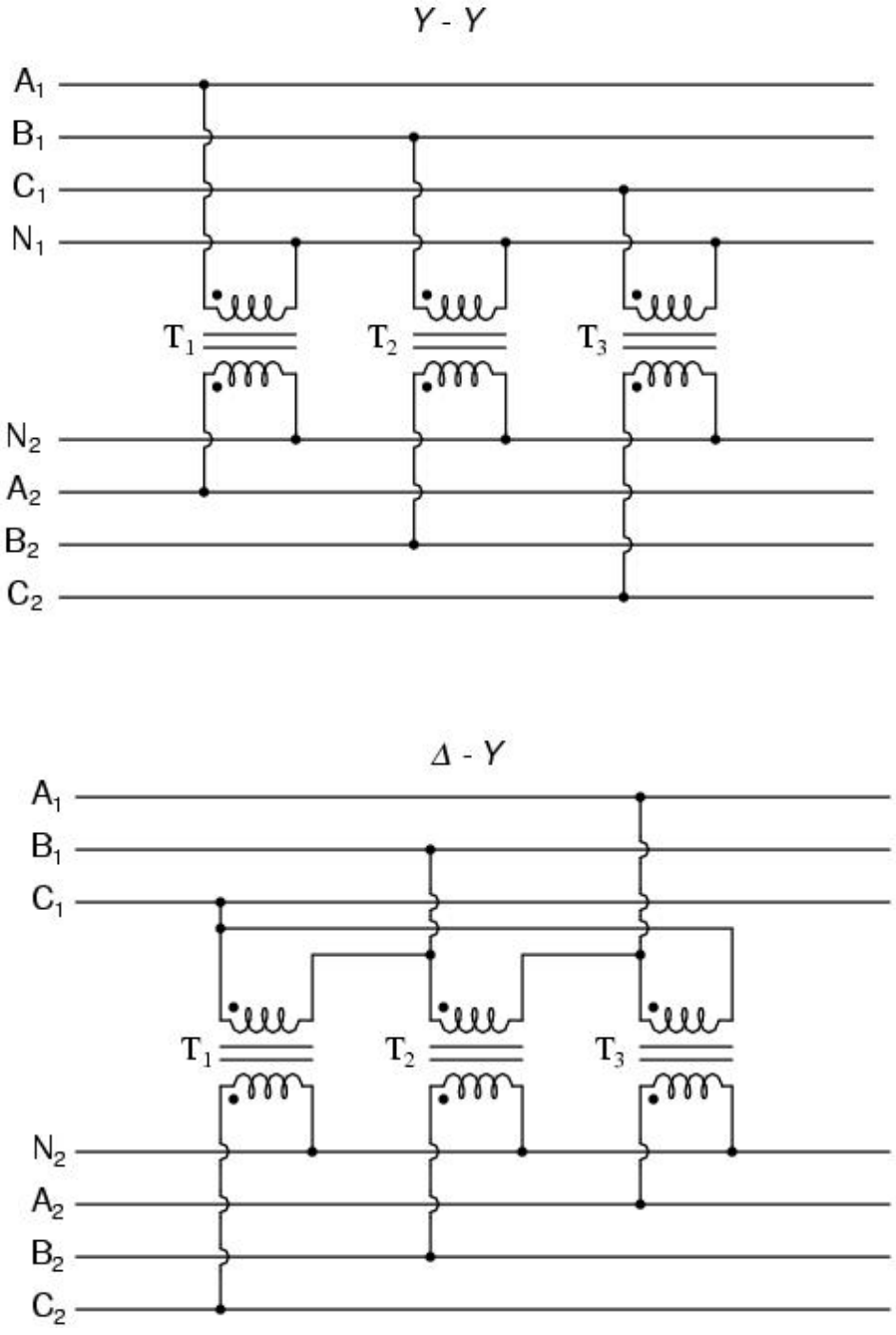
Wye/DELTA (or)Y/Δ CONNECTIONS:

This connections is at the substation of the transmission line where the voltage is to be stepped down. The primary winding is Y-connected and ground neutral. The relation between secondary and primary line voltage is 1/√3 times transformer ratio of each transformer. There is 30◦ shift between primary and secondary line voltage which means that Y-Delta transformer bank cannot be parallel with either a Y-Y as Delta-Delta bank. Also third harmonic current flows through the delta to provide a sinusoidal flux.

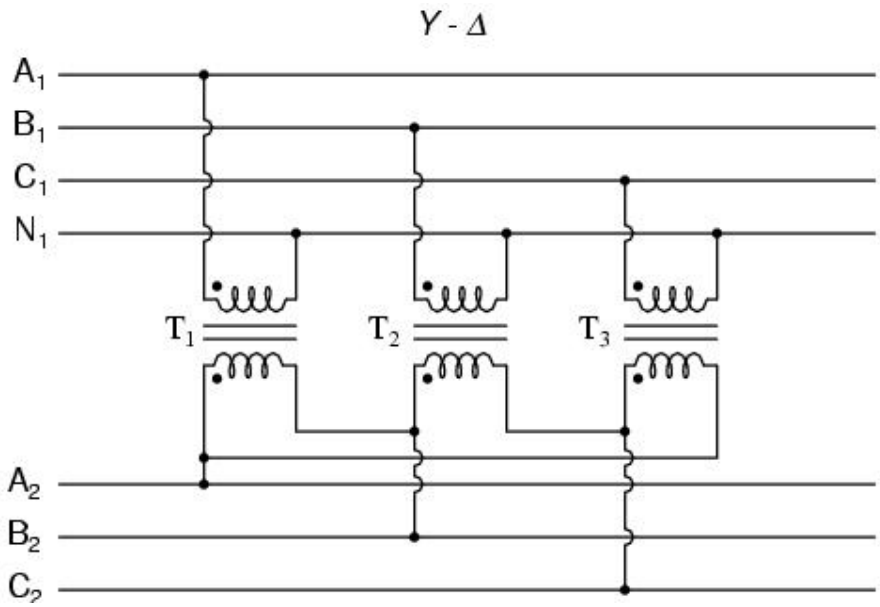
DELTA/Wye (or)Δ /Y CONNECTIONS:

This connection is generally employed when it is necessary to step up the voltage. The neutral of the secondary is grounded for providing three phase 4 wire service. This connection can be used to serve both the 3 phase power equipment and single phase lighting circuit. This connections is not open to the floating neutral and voltage distortion because of the existence of delta connection, allows the path for the third harmonic current. It would be observed that the primary and secondary line voltage and line current are out of phase with the each other by 30◦ . Because of this 30◦ shift it is impossible to parallel such a bank with a delta-delta or Y-Y bank of transformer even though the voltage ratios are correctly adjusted. The ratio of secondary of primary voltage is √3 times the transformer ratio of each transformer.

CIRCUIT DIAGRAM:



CIRCUIT DIAGRAM:



RESULT:

Thus the three phase transformer was connected in different connections and the relation were studied.

EX.NO. 13	LOAD TEST ON DC COMPOUND MOTOR
DATE:	

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	1250Ω , 0.8A		1
4	Tachometer	60000rpm	Digital	1

FUSE RATING:

125% of rated current

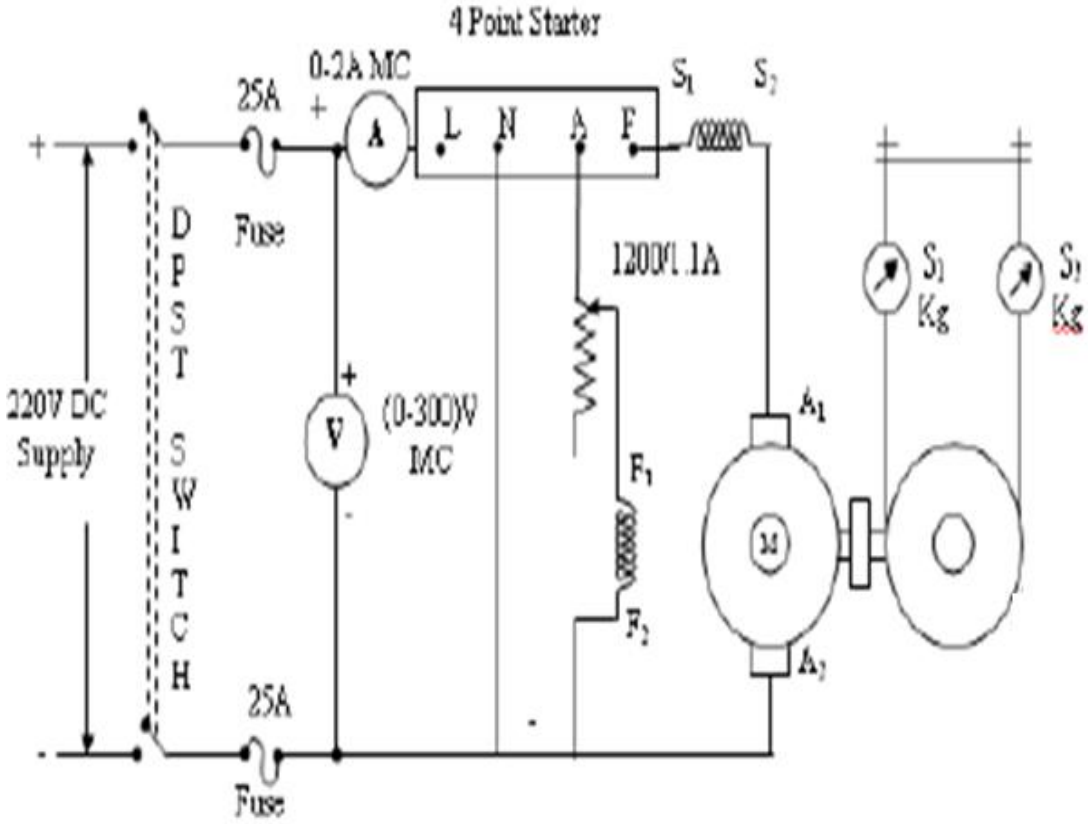
PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- The motor should be started at no load condition.
- The motor should be cooled by circulating water throughout the experiment.

PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPSTswitch.
3. Stat the motor using four point starter.
4. Adjust the field rheostat till the motor reaches its rated speed.
5. Note down the no load reading of voltmeter, ammeter, speed and spring balance reading.
6. Apply load in steps and note down the corresponding reading till the rated current is reached rated value.

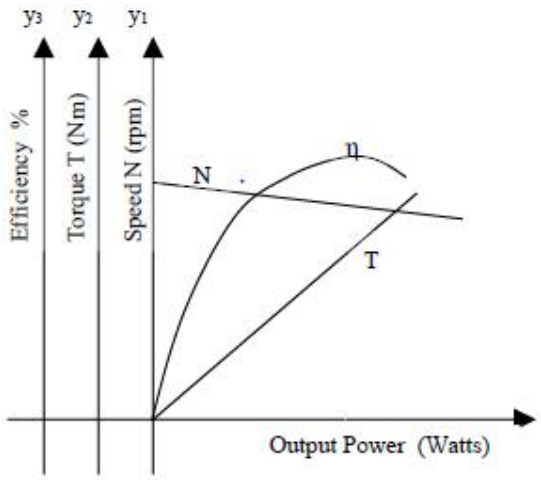
CIRCUIT DIAGRAM(LOAD TEST ON DC COMPOUND MOTOR):

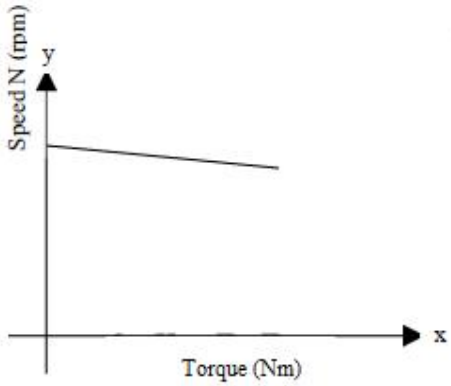


TABULATION(LOAD TEST ON DC COMPOUND MOTOR):

S.no	Voltage V *volts*	Current I *amps*	Spring balance readings		$S_1 \sim S_2$ *Kg*	Speed N *rpm*	Torque T *Nm*	Input power P_i *watts*	Output Power P_m *watts*	Efficiency ¦ %
			S_1 *Kg*	S_2 *Kg*						

MODEL GRAPHS:





FORMULAE:

- Torque (T) = **9.81(s1¼s2)R**
- Output power = **2ΠNT/60**
- Input power = **V*I**

Efficiency , %η=output power/input power * 100

Where,

9.81 = gravity constant

R = radius of brake drum

N = speed in RPM

RESULT:

Thus the load test on DC series motor was performed and the performance graphs were drawn.

EX.NO. 14	LOAD TEST ON DC COMPOUND GENERATOR
DATE:	

AIM:

To obtain the load characteristics of DC Compound generator under cumulative and differential mode condition.

APPARATUS REQUIRED:

S. No.	Apparatus	Range	Type	Quantity
1	Ammeter	(0-20)A	MC	1
2	Voltmeter	(0-300)V	MC	1
3	Rheostat	1250Ω , 0.8A		1
4	Tachometer	60000rpm	Digital	1

FUSE RATING:

125% of rated current

PRECAUTIONS:

- The motor field rheostat should be kept at minimum resistance position.
- The motor should be started at no load condition.
- The motor should be cooled by circulating water throughout the experiment.

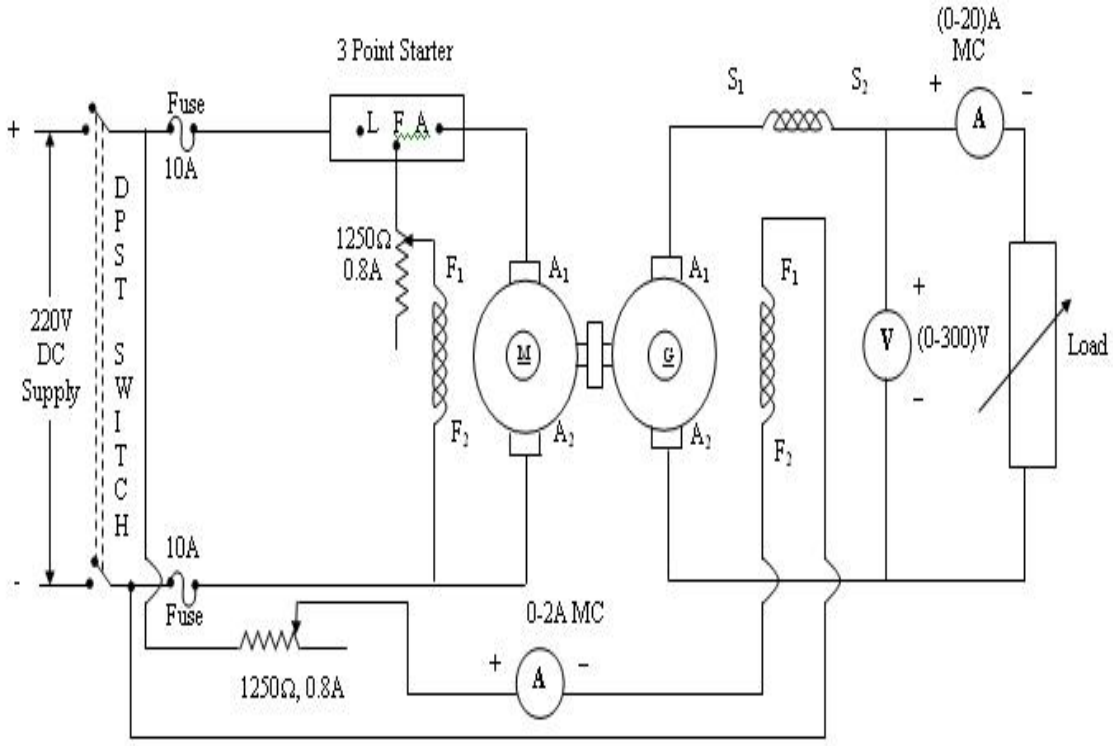
PROCEDURE:

1. Connect as per the circuit diagram.
2. Close the DPSTswitch.
3. Stat the motor using three point starter.

4.Adjust the field rheostat till the motor reaches its rated speed.

5. Note down the no load reading of voltmeter, ammeter, speed and spring balance reading.
6. Apply load in steps and note down the corresponding reading till the rated current is reached rated value.

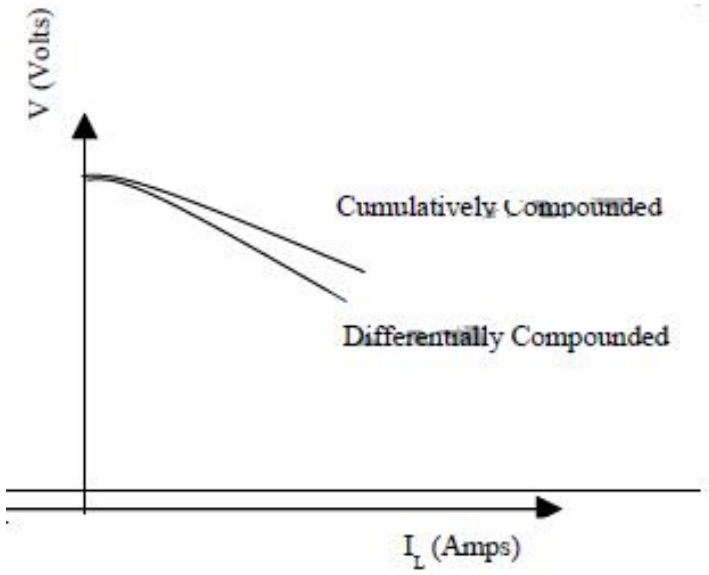
CIRCUIT DIAGRAM (LOAD TEST ON DC COMPOUND GENERATOR):



TABULATION: LOAD TEST ON DC COMPOUND GENERATOR

S.No.	Cumulatively Compounded		Differentially Compounded	
	V_L $Volts$	I_L $Amps$	V_L $Volts$	I_L $Amps$

MODEL GRAPH:



RESULT:

Thus load characteristics of DC compound generator under cumulative and differential mode condition are obtained.