EE-215-F ELECTRICAL MACHINE LAB-I

LIST OF EXPERIMENTS

1. To find out the Polarity and turn ratio of a single phase transformer.

2. To perform open and short circuit test on 1- phase transformer.

3. To perform Sumpner's Back to back test on 1-phase transformers.

4. Parallel operation of two 1-phase transformers.

5. To convert three phase to 2-phase By Scott-connection.

6. To study three phase rectifiers & supply configuration, In 3 phase.

7. To perform load test on DC shunt generator.

8. Speed control of DC Shunt motor.

9. Swinburne’s test of DC shunt motor.

10. Ward Leonard method of speed control.

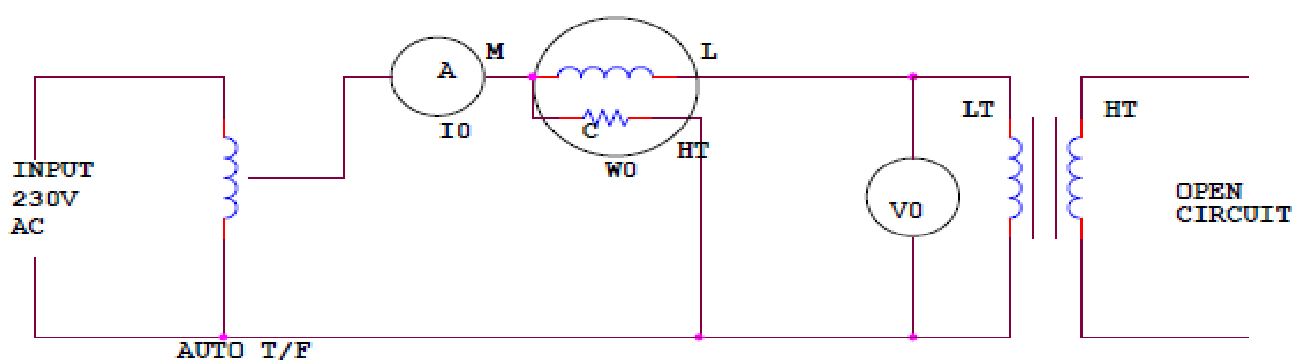
EXPERIMENT NO 02

AIM: To perform the open and short circuit test on single phase transformer.

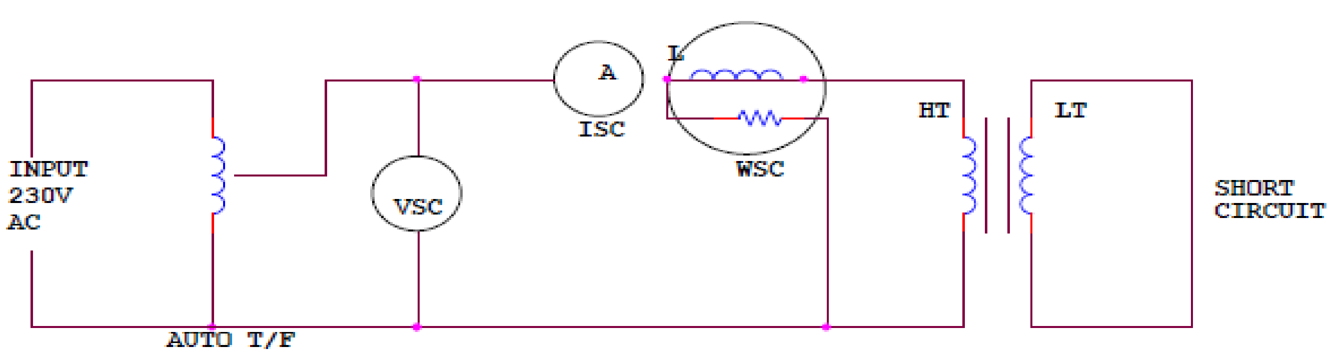
APPARATUS: One transformer, ammeter, voltmeter, wattmeter and autotransformer.

THEORY:

open circuit test is performed to find the core losses. The H.V. side is open circuited. The rated voltage is applied on the L.V. side. The shunt parameters can also be find out like Loss component of no load current, magnetizing component of no load current, Ro and Xo.



Short circuit test is carried out to find the copper losses of a transformer. In this test low voltage side is short circuited and apparatus are connected on high voltage side.



PROCEDURE:

OPEN CIRCUIT TEST

- Connect the circuit as shown in the diagram
- Apply rated voltage on the primary side.
- Take the readings of Vo, Io and Wo.
- Calculate the shunt parameters.
- Switch off the power supply.

S.NO.	V0 (V0LTS)	IO(AMPS)	W0(Watts)
1.			

The total iron loss=Wo

No load power factor=Wo/VoIo

Core loss component of the current=Iw=IoCosφ

Magnetizing component of current=Iμ=IoSinφ

Ro=V1/Iw

Xo=V1/Iμ

SHORT CIRCUIT TEST:

- Connect the circuit as shown in the diagram
- Slowly increase the supply voltage till the current is full load current.
- Record the short circuit current and applied voltage.
- Find the full load current.
- Switch off the a.c. supply

S.NO.	Vsc (V0LTS)	Isc(AMPS)	Wsc(Watts)
1.			

Total copper loss=Wsc

R= Wsc/ Isc2

Z= Vsc/Isc

X= vZ2-R2

RESULT:

- The shunt parameters and core loss can be find out with open circuit test.
- The short circuit test is performed to find the copper losses and series parameters like the resistance and reactance.

PRECAUTIONS:

1. All connections should be tight.
2. The circuit should be according to circuit diagram.
3. The power should be on when the circuit is checked.

QUESTIONS:

OPEN CIRCUIT TEST:

Q1 what information do you get from open circuit test on single phase transformer?

A1 open circuit test is performed to find out the core losses and shunt parameters

Q2 which side is kept open in case of open circuit test?

A2 High voltage side

Q3 what is the power factor of a transformer under no load condition?

A3 0.2

Q4 What is the magnitude of no load current w.r.t . Full load current?
A4 No load current is 5 percent of full load current.
Q5 what do you mean by equivalent circuit of transformer?
A5 the equivalent circuit is the representation of primary and secondary winding Resistances and reactances along with losses.
Q6 Why indirect testing of transformers is necessary?
A6 to apply the whole load is not easy to calculate the various parameters.
Q7 how does the copper losses vary with variation of load on transformer?
A7 Copper losses are directly proportional to load on the transformer.
Q8 what do you understand by all day efficiency of transformer?
A8 All day efficiency is the ratio of output energy to input energy.

SHORT CIRCUIT TEST:

Q.1 why do you perform short circuit test on transformer?
A1. To find the copper losses & series parameters of the transformer.
Q.2 which side is short circuited in short circuit test?
A2. Low voltage side
Q.3 which supply is given in short circuit test?
A3 5 % to 10 % of rated voltage
Q.4 what is the power factor of transformer?
A4 Not defined
Q.5 what is working principle of transformer?
A5 mutual induction

EXPERIMENT NO 04

AIM: To study the parallel operation of single phase transformers.

APPARATUS: Three ammeters, three wattmeter, single phase load, two transformers, autotransformer.

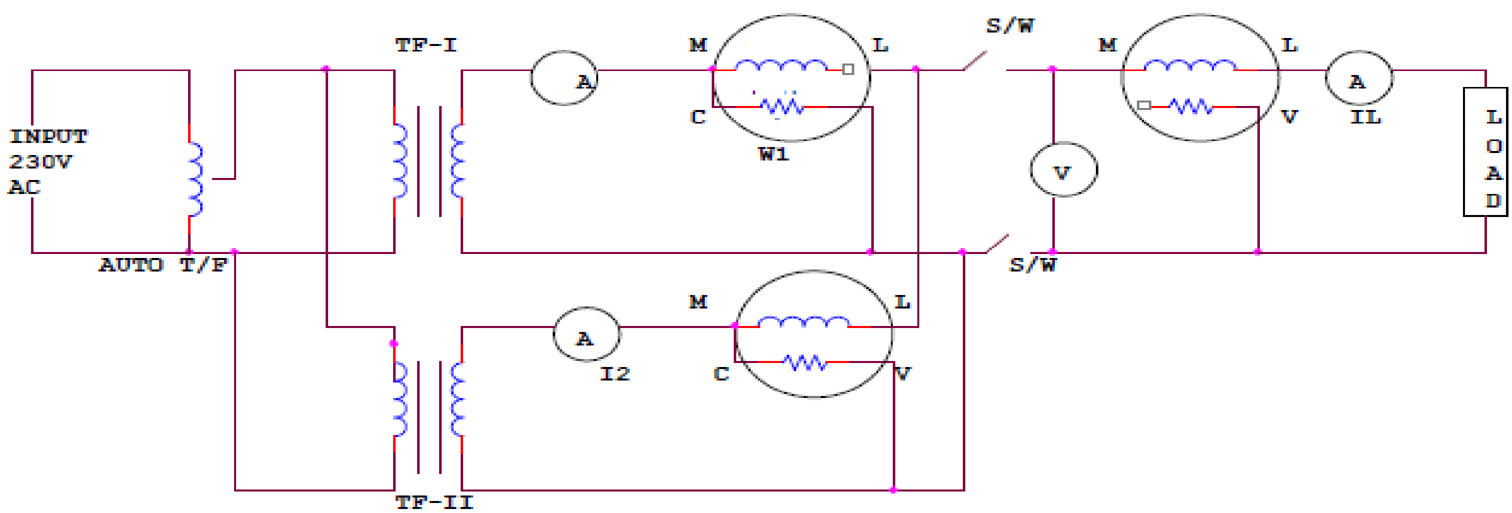
THEORY:

Parallel operation of transformers is used for load sharing. The transformers are connected in parallel on both primary and secondary side. Following conditions to be satisfied.

During the parallel operation of transformers

- Same polarities should be connected.
- The two transformers should have same voltage ratio.
- The percentage impedance should be same.
- There should be no circulating current.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as shown in the diagram.
2. Note down the readings of all wattmeter, ammeters and voltmeters for given load.
3. Repeat the above test for different values of load.
4. Take at least three readings.

OBSERVATION TABLE:

S.NO.	I1 (AMPS)	W1(WATTS)	I2(AMPS)	W2(WATTS)	IL=I1+I2 (AMPS)	WL=W1+W2 (WATTS)
1. 2. 3						

RESULT:

The two transformers connected in parallel share the load equally.

PRECAUTIONS:

1. Transformers should be connected in such a way that they have same polarity.
2. All connections should be neat and tight.
3. Connecting leads should be perfectly insulated.

QUESTIONS:

Q.1 what is the minimum no. of transformers needed to conduct this exp.?
A1 Two
Q.2 what is the effect of circulating current in the circuit having two transformers in parallel?
A2 produces additional copper losses
Q.3 when does the circulating current flow in a circuit of two transformers connected in parallel?
A3 if the two transformers have different voltage ratios
Q.4 how much circulating current can be tolerated for parallel operation of transformers?
A4 10% of rated value
Q.5 why the transformer are needed to be operated in parallel?
A5 If the load is more than rated load
Q.6 what will happen if two transformers are connected in parallel with wrong polarity?
A6 Dead short circuit on the transformers
Q.7 what are the different polarities of transformer?
A7 Positive and negative
Q8 what do you mean by impedance of transformer?
A8 combination of resistance and reactance
Q9 what is the working principle of transformer?
A9 Mutual induction
Q10 what do you mean by load sharing?
A10 the total load is distributed on transformers equally.

EXPERIMENT NO 01

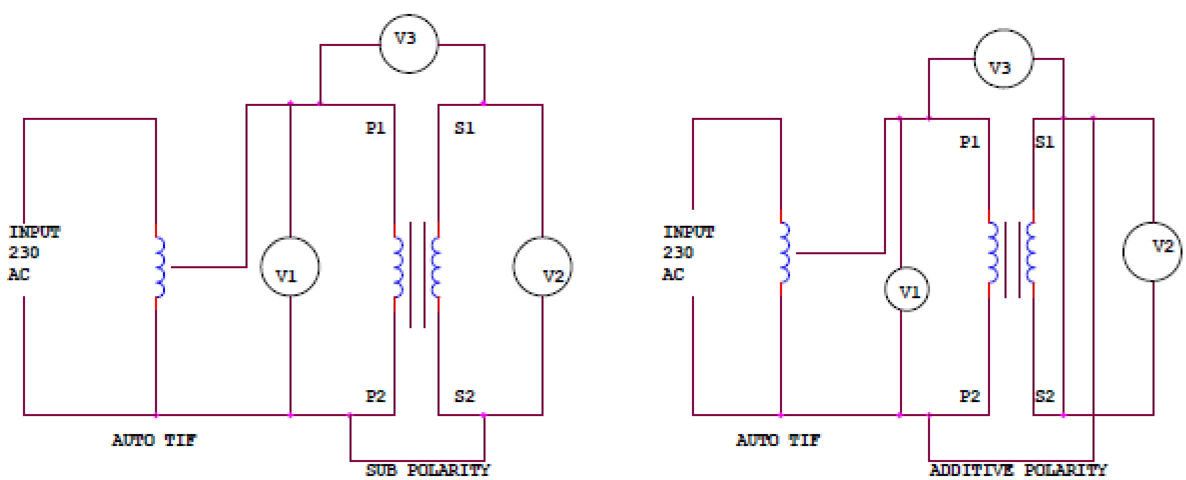
AIM: To find the polarity and turns ratio of a single phase transformer.

APPARATUS: One transformer, two voltmeters, one autotransformer, connecting wires.

THEORY:

It is essential to know the relative polarity at any instant of primary and secondary terminals for making correct connections. When the two transformers are to be connected in parallel to share the load on the system, the marking is correct if voltage V3 is less than V1. Such a polarity is termed as subtractive polarity. The standard practice is to have subtractive polarity because it reduces the voltage stress between adjacent loads. In case V3 > V1, the emf induced in primary and secondary have additive relation and transformer is said to have additive polarity.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Polarity test:
    - Connect the circuit as shown in the diagram.
    - Switch on the single phase a.c. supply.
    - Record the voltages V1, V2 and V3 .In case V3<V1 polarity is subtractive.
    - Repeat the step 3.In case V3> V1 polarity is additive.
    - Switch off the a.c. supply

2. Turn Ratio Test:
    - Connect the circuit as shown in the diagram.
    - Switch on the a.c. supply.
    - Record voltage V1 across primary and V2 across various tappings of secondary.
    - If V1>V2 then transformer is step down.
    - If V2> V1 then transformer is step up.
    - Switch off a.c. supply.

OBSERVATION TABLE:

SUB-POLARITY

S.NO.	V1	V2	V3=V2-V1

ADD-POLARITY

S.NO.	V1	V2	V3=V1+V2

TURN RATIO

S.NO.	V1	V2	TURN RATE V1/V2

RESULT:

If V2>V1 then transformer is step up otherwise step down.

PRECAUTIONS:

1. All connections should be tight.
2. The circuit should be according to circuit diagram.
3. The power should be on when the circuit is checked

QUESTIONS:

Q1 what is transformer?

A1 Transformer is a static device which is used to change the level of voltage or current without Changing the frequency and power.

Q2 what do you mean by turns ratio of transformer?

A2 Turns ratio of a transformer is the ratio of primary turns to the secondary turns.

Q3 what is transformation ratio of transformer?

A3 Transformation ratio is the ratio of secondary side turns to primary side turns.

Q4 what is the condition of additive polarity?

A4 When the sum of voltages is more than individual voltages, then it is called additive

Q5What is the condition for subtractive polarity.

A5 When the sum of voltages is less than individual voltages, and then it is called subtractive.

Q6 what is the use of autotransformer?

A6 Autotransformer is used for increasing or decreasing the voltage with the use of one winding

Q7 what is the use of polarity test?

A7 the polarity test is performed to find the positive and negative polarity of transformer.

Q8 what is the transformation ratio of step-up transformer?

A8 It is always more than unity.

EXPERIMENT NO 05

AIM: To convert three phase to 2-phase By Scott-connection.

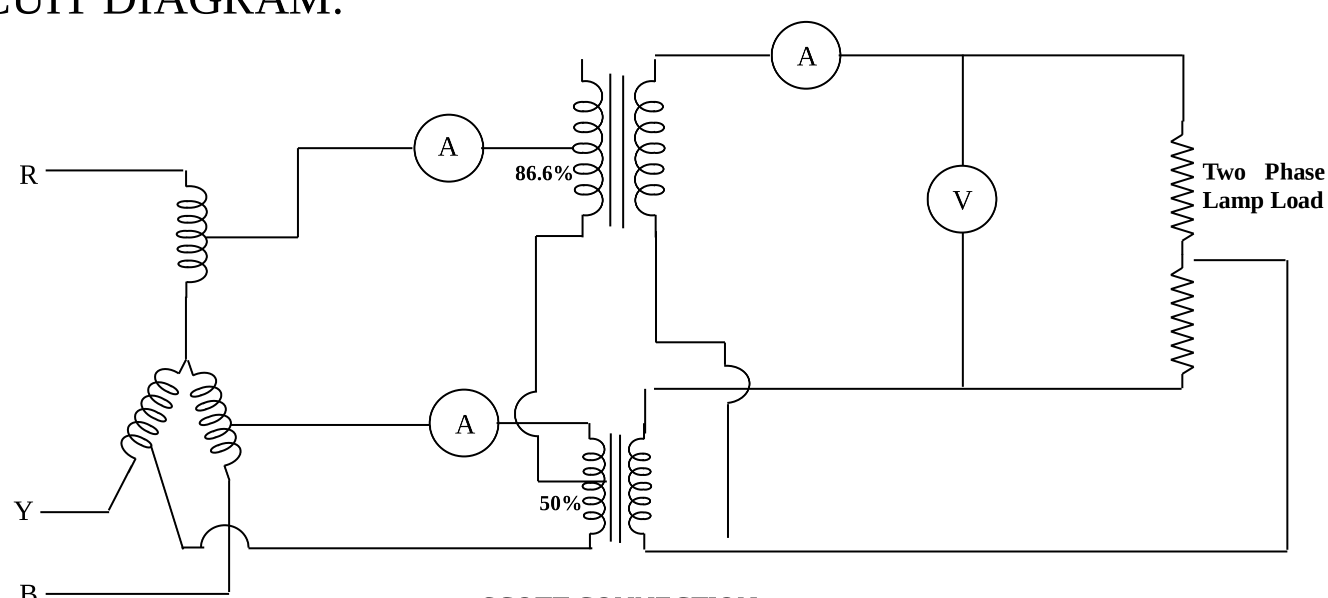
APPARATUS: Three phase autotransformer, lamp load, ammeter, and voltmeter.

THEORY: Three phase to two phase conversion or vice versa is essential under the following circumstances.

1. To supply power to two phase electrical furnaces.
2. To supply power to two phase apparatus from three phase source.
3. To interlink three phase system and two phase system.

The common type of connection which can achieve the above conversion is normally called scott connection. By this method the two phase supply can be supplied from three phase supply in balanced condition.

CIRCUIT DIAGRAM:



SCOTT CONNECTION

PROCEDURE:

1. Connect the circuit as per diagram.
2. Ensure that the switches S1 and S2 are open.
3. Adjust the three phase variac for minimum voltage in it's output circuit.
4. Switch on the ac supply and apply rated voltage across primaries at the transformer.
5. Record the voltage V1,V2 and V3 and verify that the output is balanced to power supply.
6. Switch off the power supply and remove the dotted connection of the two secondary and voltmeter V3.
7. Switch on the supply and again adjust the output voltage of variac as per rated voltage.
8. Close the switches S1 and S2 to load the secondary. Adjust equal loading of both secondaries. Record the equal reading of both secondaries and record the reading of the meters.
9. Switch of the power supply.

OBERSVATION TABLE:

S.NO	AMMETERS READING					VOLTAGE	
	I2m	I2t	I1	I2	I3	V1	V2
1.							
2.							
3.							

Precautions:

1) All the connections should be tight & clean.
2) The range of instruments should be carefully selected.

EXPERIMENT NO 03

AIM: To perform the Sumpner's test on two identical transformers.

APPARATUS: Two single phase transformers, two ammeters, three voltmeters, wattmeter.

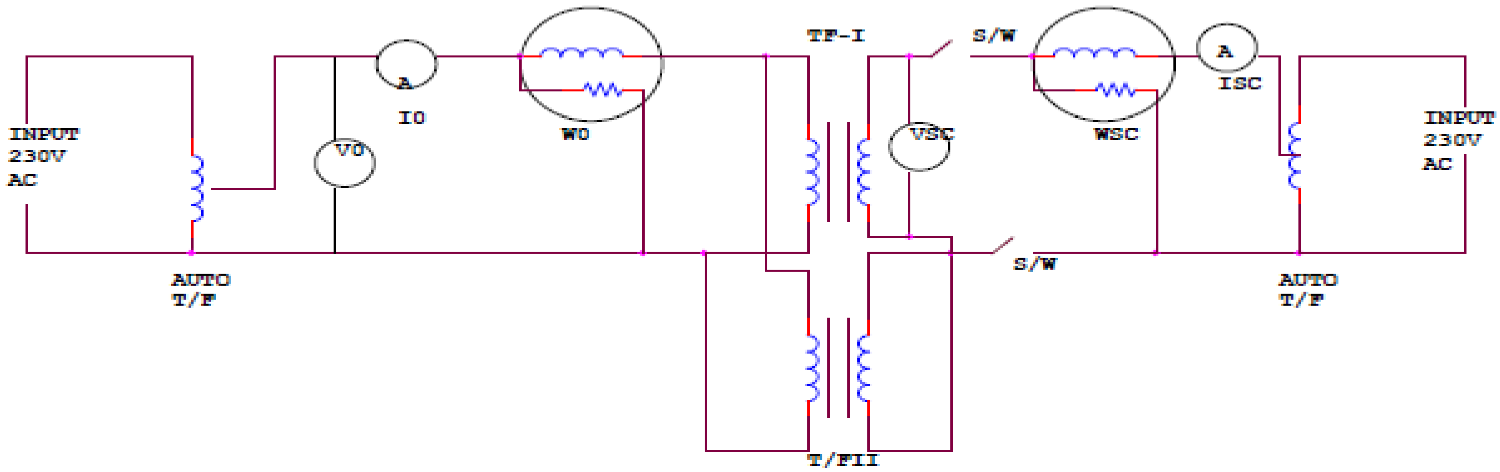
THEORY:

This test facilitates the collection of data for open circuit and short circuit test simultaneously. Two identical transformers are needed. Both the transformers are connected in parallel. These are fed by rated voltage at rated frequency. The secondary winding of both the transformers is connected in phase opposition. On secondary side a low voltage just sufficient to flow the full load current is connected once the transformer is
Connected in such a manner, rated iron losses occur in core and copper losses occur in windings.

We can justify that the current is just twice the no load current this means the wattmeter connected on the primary side reads the total iron loses of both the transformers.

The iron loss of one transformer=1/2 Wo
The copper loss of one transformer=1/2 Wc
The total losses of one transformer=1/2 WO+1/2 Wc
Efficiency at full load= output power/ (Output power + losses)

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as shown in the diagram
2. Apply 230v A.C. supply to primary side.
3. Note down the readings of Wo,Xo and Vo
4. Full rated current to secondary side.
5. Note down the readings of Wsc,Isc and Vsc.
6. Calculate total losses and efficiency using above formulae

OBSERVATION TABLE:

S.NO.	V0 (VOLTS)	I0 (AMPS)	W0 (WATTS)	VSC(VOLTS)	ISC(AMPS)	WSC(WATT)

RESULT:

Total losses of a transformer are equal to sum of iron loss plus copper losses

PRECAUTIONS:

1. All connections should be neat and tight.
2. Connecting leads should be perfectly insulated.
3. There should be no error in ammeter and voltmeter.
4. The range of instruments should be carefully chosen.

QUESTIONS:

Q1 How can you determine the efficiency of transformer?
A1 By load test, open circuit and short circuit test and Sumpner's test
Q2 How much voltage is applied on primary side while conducting the Sumpner's test?
A2 Normal rated voltage
Q3 How much voltage is applied on secondary side while performing the experiment?
A3 10% to 15% of the rated voltage
Q4 How the secondary winding of transformers are connected for conducting the Sumpner's test.
A4 the windings are connected in phase opposition
Q5 How much current flows on primary side and secondary side of transformer while performing the experiment.
A5 5% to 7% of rated current on primary side and full rated current on secondary side
Q6 what do you mean by phase opposition in reference to Sumpner's test on transformer?
A6 When the output voltage is equal to difference of two voltages
Q7 what is the condition to be satisfied by the two transformers to be tested through Sumpner's test?
A7 Two transformers should be identical
Q8 what does the reading of wattmeter on primary side indicate?
A8 Total iron losses of both transformers

EXPERIMENT NO 09

Aim: To perform Swinburn's test on a d.c. shunt motor & find out efficiency at full load.

Apparatus:

		Qty	Range
1) D.C. shunt motor		01	-
2) D.C. ammeter			
	a)	01	0-2 amps
	b)	01	0-5 amps
3) D.C. voltmeter		01	0-300 volts
4) Rheostat			
	a)	01	100 ohms, 5 amps
	b)	01	1000 ohms, 1 amps
5) Tachometer		01	-

Theory:

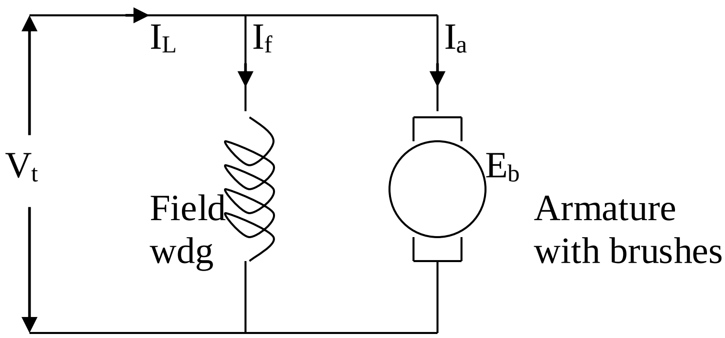
By testing of any machine, it is meant to find out the efficiency of the machine. This method of testing is named as Swinburn's test. It is an indirect method of testing (i.e. the machine is not putting on direct load).

In this test we have to obtain the losses of the shunt motor.
There are two losses:

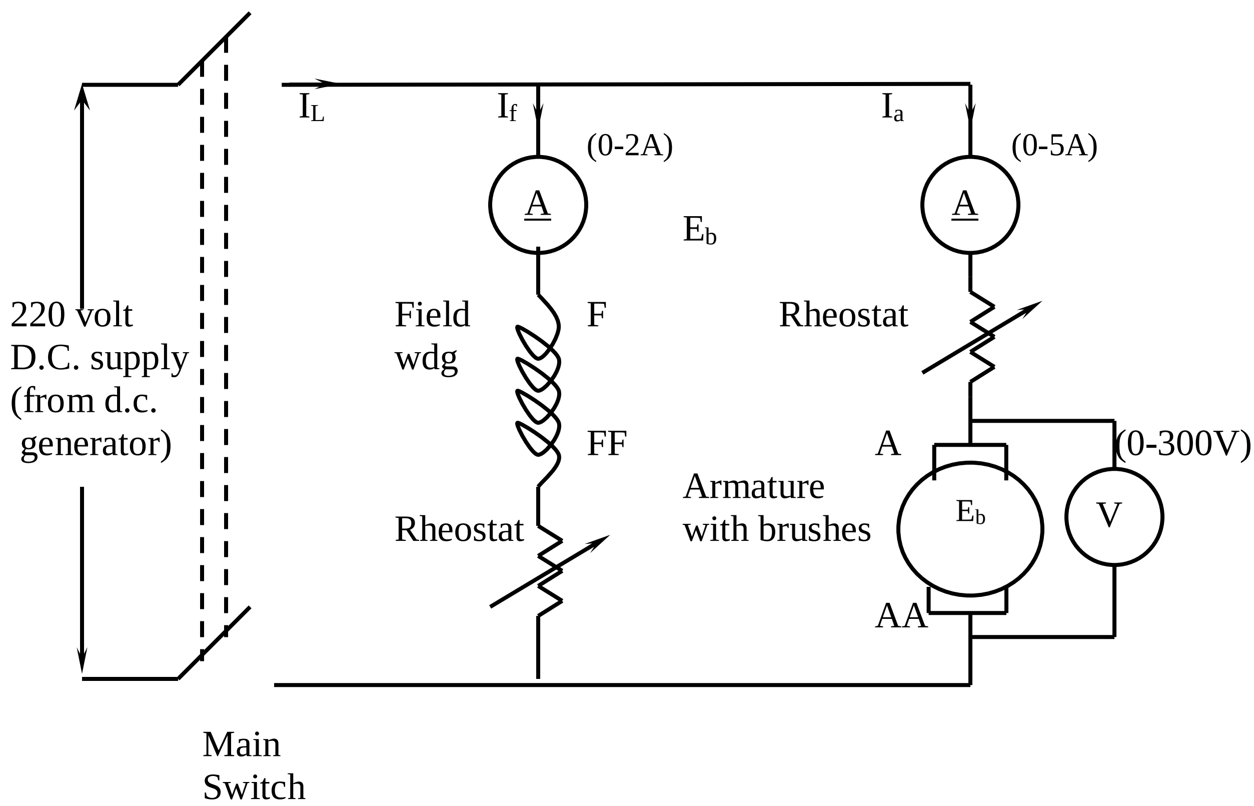
a) Constant losses (or core losses).
b) Variable losses (or Copper losses).

Constant losses are independent of the load whereas Variable losses are directly proportional to the square of armature current (appx. Equal to the load current).

In this method of testing, the constant losses are determined by operating the machine at no-load at rated voltage & rated speed. Variable losses are only calculated from the known ratings (i.e. from name plate of the shunt motor).
Let the motor is running on no-load & also, let the supply current be I_L. The current through armature be I_a & the current the current through field winding be I_f.
Equivalent circuit diagram of D.C. shunt motor



Circuit Diagram:



Procedure:

1) Connect the circuit as shown in the circuit diagram.
2) Ensure that the field rheostat is at zero position & the armature rheostat is at its maximum position.
3) Switch on the d.c. supply & reduce the armature rheostat to zero position slowly.
4) Record the readings of all the instruments connected in the circuit.
5) Bring the armature rheostat to its maximum position & switch off the d.c. supply.

Observation table:

S.No.	Supply voltage (V_t), volts	Armature current (I_a), amps	Field current (I_f), Amps

Calculation:

Input power to the armature circuit = $V_t I_a$
Input power to the shunt field circuit = $V_t I_f$
Input power to the motor at no load (W_o) = $V_t(I_a + I_f)$
Armature copper losses at no load = $I_a 2\ R_a$

Now

Constant losses of machine = $W_o - I_a^2 R_a$

Let the rated output of the machine when operating as motor be P_o watts.
Let us assume suitable value of full load efficiency of the motor say 85%.

Then, rated input of the motor = $P_o / .85$

Power input by the motor = $V_t I_L$ = Po / .85
With this we can calculate $I_L = P_o / (.85 * V_t)$

Now
Armature current under full load, $I_{afL} = I_L - I_f$
Armature copper losses at full load = $I_{afL}^2 R_a$.

Total losses at full load = Constant losses + Variable losses
= $W_o + I_{afL}^2 R_a$

Therefore,

The efficiency of the d.c. machine operating as motor

$(\eta) = P_o / (P_o + W_o + I_{afL}^2 R_a)$

Result: The efficiency of the d.c. shunt motor has been calculated & it is found to be……………

Precautions:

1) All the connections should be tight & clean.
2) When starting the motor, the field rheostat should be at its minimum position & armature rheostat is at its maximum position,
3) Before switching off the supply, the armature rheostat should be moved to its maximum position.
4) The range of instruments should be carefully selected.

Questions to prepare (To be answered in practical note book)**:**

1) What is Swinburn's test?
2) How much rise in the temperature of the motor in this test?
3) What is the important point to be noted before doing this test?
4) What is the advantage of this test?
5) What are the various losses occurred in the d.c. machine?

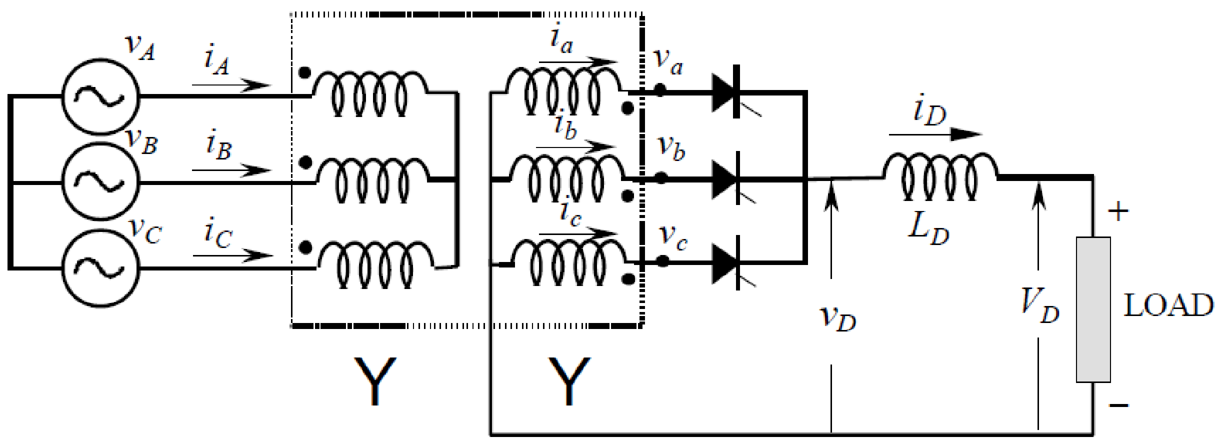
EXPERIMENT NO 06

AIM: To study three phase rectifiers & supply configuration, In 3 phase.

THEORY:

Three-phase controlled rectifiers have a wide range of applications, from small rectifiers to large High Voltage Direct Current transmission systems. They are used for electro-chemical process, many kinds of motor drives, traction equipment, controlled power supplies, and many other applications.

Three-phase half-wave rectifier



Three-phase half-wave rectifier

The figure shows the three-phase half-wave rectifier topology. To control the load voltage, the half wave rectifier uses three, common-cathode thyristor arrangement. In this figure, the Power supply, and the transformer are assumed ideal. The thyristor will conduct (ON state), when the anode-to-cathode voltage *vAK* is positive, and a firing current pulse iG is applied to the gate terminal. Delaying the firing pulse by an angle a does the control of the load voltage. The firing angle a is measured from the crossing point between the phase supply voltages, as shown in figure . At that point, the anode-to-cathode thyristor voltage *vAK* begins to be positive. The figure shows that the possible range for gating delay is between a=0° and a=180°, but in real situations, because of commutation problems, the maximum firing angle is limited to around160°. In figure 12.4, when the load is resistive, the current *id* has the same waveform of the load voltage. As the load becomes more and more inductive, the current flattens and finally becomes constant. The thyristor goes to the non-conducting condition (*OFF* state) when the following thyristor is switched *ON*, or the current, tries to reach a negative value.

Where *VMAX* is the secondary phase-to-neutral peak voltage, *Vf-Nrms* its *rms* value, and w is the angular frequency of the mains power supply. It can be seen from equation (12.1) that changing the firing angle a, the load average voltage *VD* is modified. When a is smaller than 90°, *VD* is Positive, and when a becomes larger than 90°, the average *dc* voltage becomes negative. In such a case, the rectifier begins to work as an inverter, and the load needs to have the capability to generate power reversal by reversing its *dc* voltage.

THREE-PHASE SUPPLY CONFIGRATIONS:

3-Phase power often denoted as 3Φ is the most efficient way to produce and distribute electricity. Nearly all power in the world today is generated as 3-Phase. 3-Phase power combines three electric circuits into one and is supplied over three wires which are typically labeled X, Y and Z. The line voltages between the three possible pairs of wires are XY, YZ and XZ.

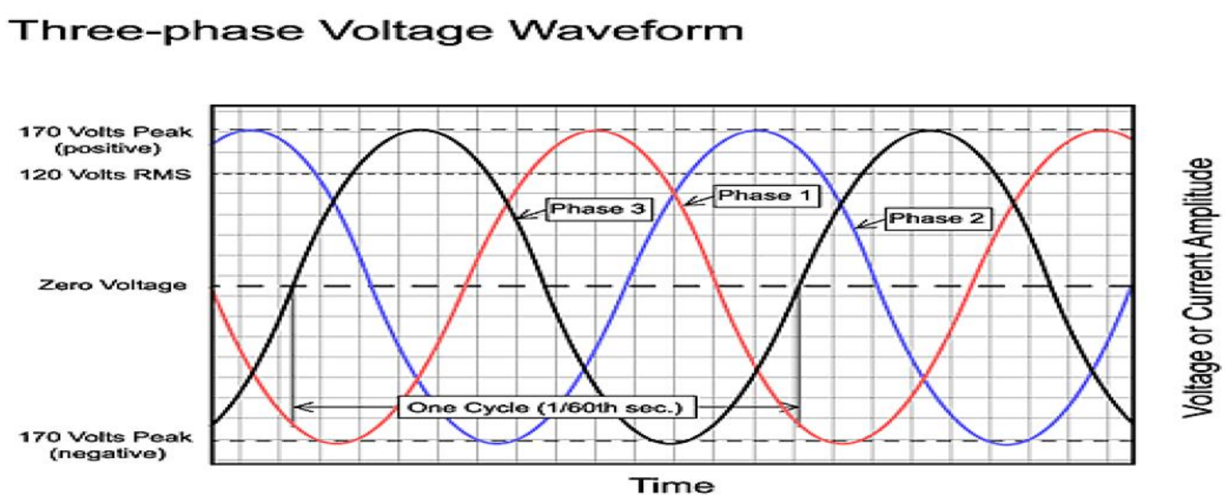


Figure 1

3-Phase power is delivered in either a Delta or Wye configuration source. A delta configuration consists of 3 line wires. Looking at the diagram it is obvious why it is called a delta configuration as it resembles the Greek letter of the same name Δ. A 3-Phase delta configuration, supplies three 230 V single phase power outputs to power IT equipment via V_{xy}, V_{yz} and V_{xz}.

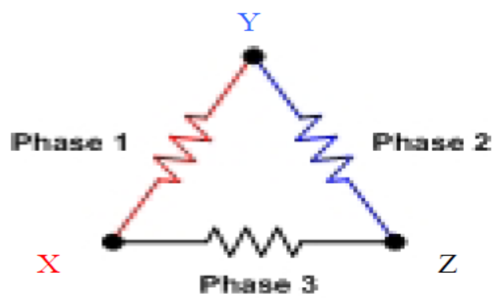


Figure 2

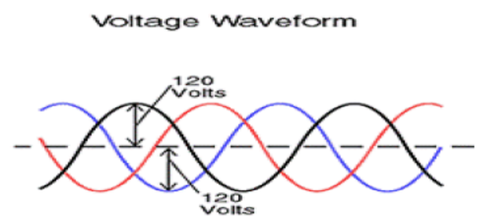


Figure 3

3-Phase Wye power consists of 3 line wires, a common neutral wire, and one ground wire. Again looking at the wiring diagram it is obvious why it is called a Wye as it is shaped like a “Y”. Due to the one additional neutral wire, 3-Phase Wye configurations can supply both 120V and 230 V single phase outputs. 120 V is supplied to a load by connecting the common neutral wire to any one of the three lines X, Y and Z. 230 V is derived by connecting a load to any two of the 120 V lines XY, YZ, XZ and because of this it is often called dual phase power. 230 V is supplied from the two 120 V line voltages as (120 V x 1.73) = 230 V not 240 V or (120 V + 120 V) = 240 V as might be expected.

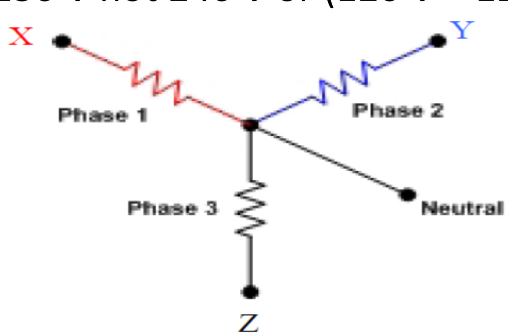


Figure 4

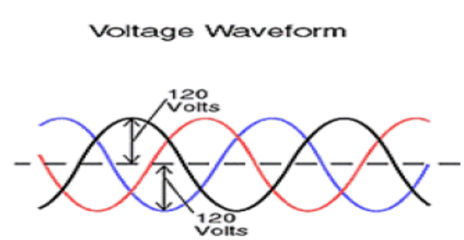


Figure 5

- P = V (volts) x I (Amps) or VA or Watts in a single phase system.
- For a 3-Phase system P =V x I x 1.732 is used to determine VA or Watts.

All calculations assume a power factor of 1 (p.f. =1)

RESULT:

The study of 3-ϕ rectifier and 3-ϕ supply system configurations has been done successfully.

EXPERIMENT NO 07

AIM: TO perform load test on D.C. shunt generator. Also draw the load characteristics i.e. V_L v/s I_L.

Apparatus required:

	Range	Qty
1. Motor Generator set		
2. Voltmeter (dc)	0-300V	1
3. Ammeter (dc)	0-5A	1
	0-10A	1
4. Voltmeter (AC)	0-500V	1
5. Tachometer		
6. Rheostat	0-1000 Ω, 1A	1
	0-100 Ω, 5A	1
7. Electric lamp load or rheostat		

Theory:

The term load characteristic signifies the changes takes place in a d.c. generator under load conditions.

Under load conditions, output terminal voltage

$$\mathbf{V_L = E - I_a R_a - V_b} \text{............}(1) \qquad \&$$

$$\mathbf{I_a = I_L + I_f}$$

where

V_b = brush voltage = 2 volt

I_L = load current

R_a = armature resistance.

E can't be directly measured but can be estimated by using equation (1)

The load characteristics depends on the load current & excitation conditions of the machine.

To obtain load characteristics field resistance should be constant. An initial reduction in load resistance causes an increase in the load current giving rise to more voltage drop in the machine & reduction of emf due to armature reaction. Hence terminal voltage will decrease. This fall in terminal voltage also causes a reduction in the field current. This will give rise to further reduction in voltage.

When the load current reaches a certain maximum value, which is much greater than the full load current, the load resistance shunts the field winding to such an extent that the terminal voltage drops more rapidly than the load resistance. Further decrease in load resistance actually causes a decrease in current with decrease in voltage & the characteristics turns back.

When the armature terminals are short circuited (i.e. $R_L = 0$) the extended characteristics cuts the x-axis at some point. This is due to the fact that for load resistance , $I_a \approx I_L$ & $I_f \approx 0$ and hence E is very small caused only due to residual magnetism. Thus, shunt generators are self protective against accidental short circuit.

Procedure:

1) Connect the circuit as shown in figure.
2) Switch on the supply voltage.
3) Apply the load across the load terminals of the generator.
4) Note down the readings of voltmeter & ammeter.
5) Repeat step 3 & 4 for as many readings as possible.

Observation:

S.No.	V_L (volts)	I_L (amps)	$E = V_L + I_L R_a + V_b$ (volts)

Result: Load characteristics of the d.c. shunt generator obtained. The graph between V_L & I_L was plotted.

Precautions:

1) All the connections should be neat & tight.
2) While performing experiment take care that the instrument readings should not exceed the ratings of the machines under test.
3) During the experiment the speed of the prime mover should remain constant.Beware of the high d.c. voltage.

<u>**EXPERIMENT NO 08**</u>

Aim: To study the speed control of a d.c. shunt motor using

a) Field current control.
b) Armature voltage control.

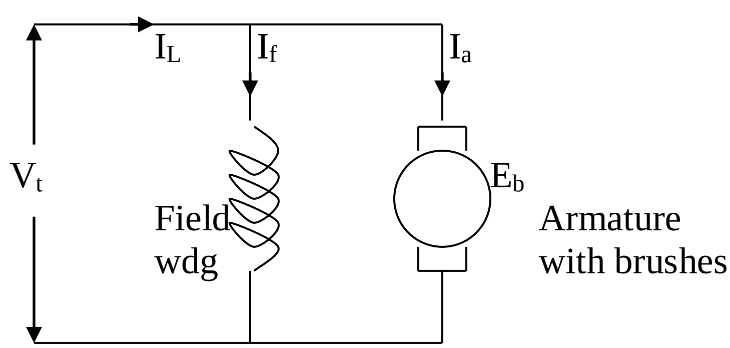
Apparatus:

		Qty	Range
1) D.C. shunt motor		01	-
2) D.C. ammeter			
	a)	01	0-2 amps
	b)	01	0-5 amps
3) D.C. voltmeter		01	0-300 volts
4) Rheostat			
	a)	01	100 ohms, 5 amps
	b)	01	1000 ohms, 1 amps
5) Tachometer		01	-

Theory:

D.C. shunt motor is a type of d.c. motors, in which the field winding is connected in parallel with the armature & it is used where the constant speed is required. As the speed control of any motor is necessary therefore speed control of d.c. shunt motor is also necessary. In this experiment we will study the two different methods of speed control of d.c. shunt motor viz. field & armature control.

The equivalent circuit diagram of d.c. shunt motor is shown below:



Voltage equation, $V_t = E_b + I_aR_a$ ------------- (1)

Current equation, $I_L = I_a + I_f$ ------------------ (2)

Where,

V_t	=	Terminal voltage.
E_b	=	Back E.M.F.
I_L	=	Input current.
I_a	=	Armature current.
I_f	=	Field winding current.
R_a	=	Armature winding resistance.

The equation governing the speed of a d.c. shunt motor is (using above voltage equation)

$$E_b = (\phi\ P\ N\ Z) / 60A \text{ ----------- } (3)$$

P,Z,A,60 are constants.

$$(V_t - I_aR_a)\ \alpha\ N\phi \text{ ---------- } (4)$$

where

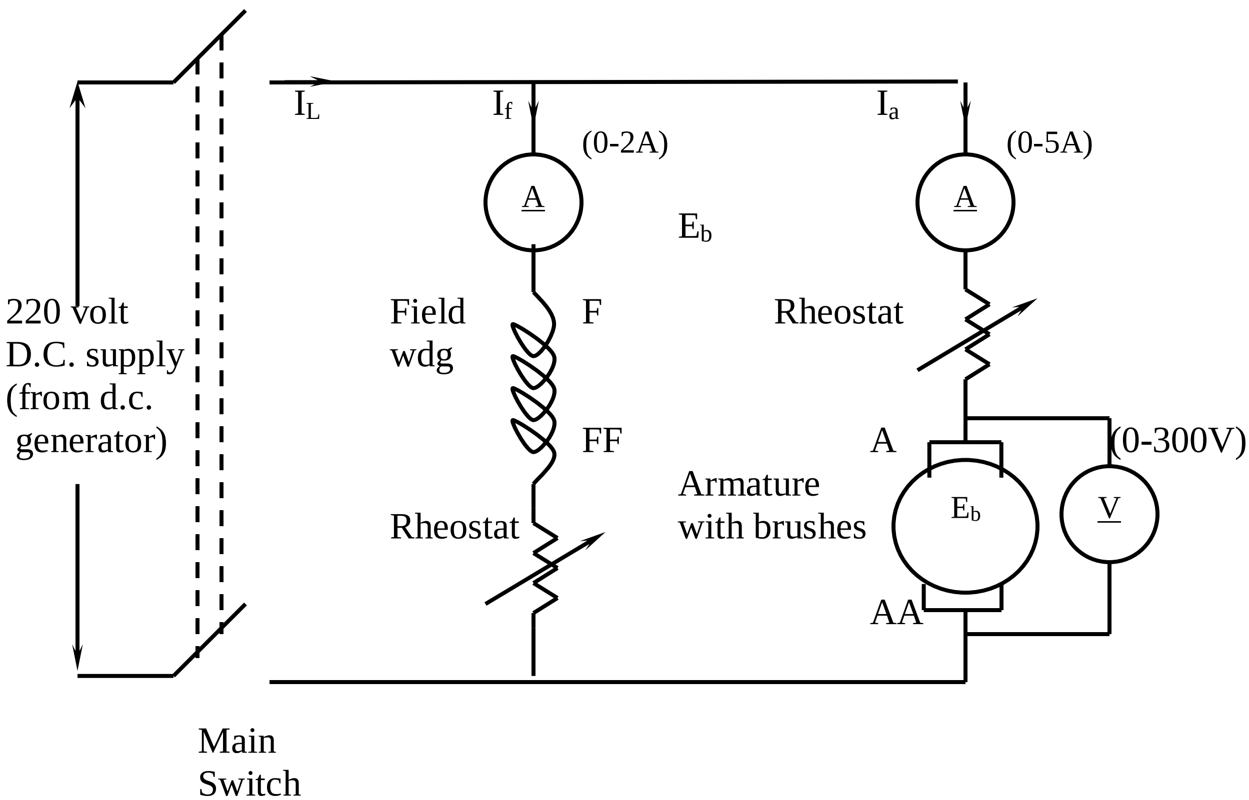
P =	No. of field poles.
Z =	Total no. of conductors.
A =	Parallel paths.
N =	Speed in rpm.
ϕ =	Field flux in webers.

$$N\ \alpha\ (V_t - I_aR_a) / \phi \text{ -------- } (5)$$

Eq (5) is speed governing equation of d.c. shunt motor.

Out of the four parameters on the r.h.s. of eq(5), R_a is constant. We can control the speed of the motor by changing the field flux & by changing the armature voltage. Rheostat in the field & armature circuit is used to vary the field flux (or field current) & the voltage across the armature of the machine respectively in order to get the different speeds.

Circuit Diagram:



Procedure:

1) Connect the circuit as shown in the circuit diagram.
2) Keep the armature rheostat to its maximum value & the field rheostat to its minimum value.
3) Switch on the d.c. supply.
4) Note down the speed, field current & armature voltage.
5) For various positions of armature rheostat repeat the step no 4, till the armature rheostat reaches its minimum value. The field current should remain constant.
6) This completes the speed control by armature control. Draw a graph between N v/s V(voltage across armature).
7) Next, keep the armature rheostat at its minimum value. Increase the field rheostat in steps & note down the readins as mentioned in step 4, till field rheostat is at its maximum value.
8) This completes the speed control by field current. Draw a graph between N v/s If (field current).
9) Last step which is very important is to bring the armature rheostat to its maximum value & switch off the d.c. supply

Result:

The graph for speed control of d.c. shunt motor by field & armature control method is obtained.

Precautions:

1) All the connections should be tight & clean.
2) When starting the motor, the field rheostat should be at its minimum position & armature rheostat is at its maximum position,
3) Before switching off the supply, the armature rheostat should be moved to its maximum position.
4) The range of instruments should be carefully selected.

Questions to prepare (To be answered in practical note book)**:**

1) Why the rheostat in series with armature in this practical is to keep its maximum position?
2) What should we do to reverse the direction of d.c. shunt motor.
3) What are the limitations of armature control method for speed control of d.c. shunt motor?
4) Name the advantages of field control method for controlling the speed of a d.c. shunt motor?
5) Why is speed of a d.c. shunt motor is constant.

Observation Table:

1) Field current control method

S.No.	Field current (If), amps	Speed (N), r.p.m.	Armature voltage, volts

2) Armature voltage control method:

S.No.	Armature voltage, volts	Speed (N), r.p.m.	Field current (If), amps

EXPERIMENT NO 10

AIM: to perform speed control of DC motor using Ward Leonard system.

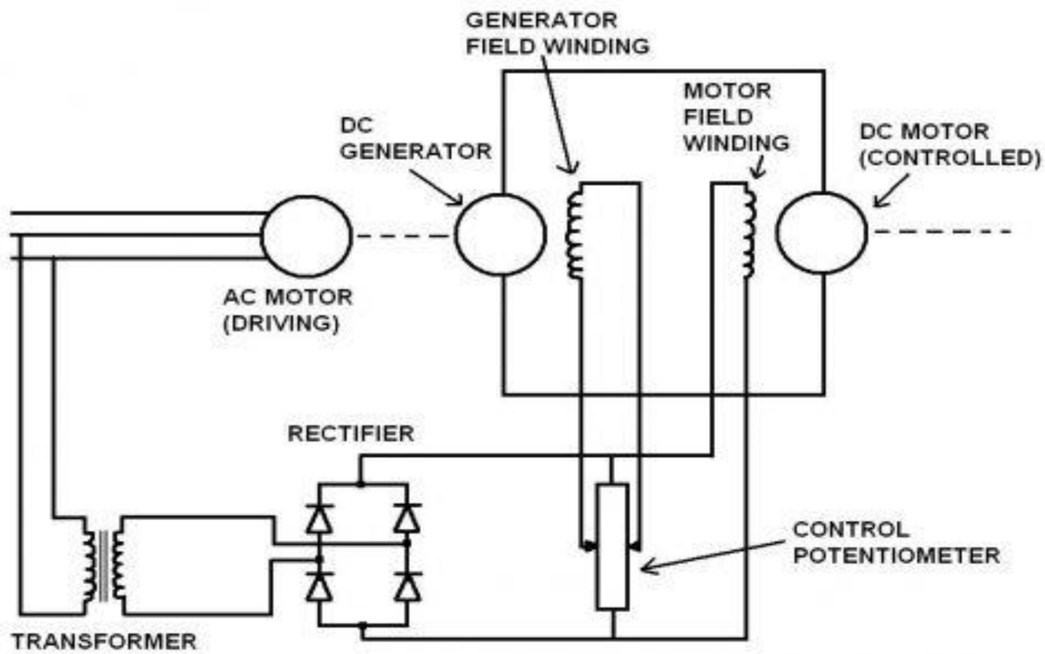
APPARATUS:

1. Ward Leonard system.
2. Connecting wires.

THEORY:

A Ward Leonard drive is a high-power amplifier in the multi-kilowatt range, built from rotating electrical machinery. A Ward Leonard drive unit consists of a motor and generator with shafts coupled together. The motor, which turns at a constant speed, may be AC or DC powered. The generator is a DC generator, with field windings and armature windings. The input to the amplifier is applied to the field windings, and the output comes from the armature windings. The amplifier output is usually connected to a second motor, which moves the load, such as an elevator. With this arrangement, small changes in current applied to the input, and thus the generator field, result in large changes in the output, allowing smooth speed control. Armature voltage control only controls the motor speed from zero to motor base speed. If higher motor speeds are needed the motor field current can be lowered, however by doing this the available torque at the motor armature will be reduced. The advantage for this method is that the speed of the motor can be controlled in both the directions.

CIRCUIT DIAGRAM:



WARD LEONARD SYSTEM OF SPEED CONTROL

The system is made up of a driving motor which runs at almost constant speed and powers a dc generator as shown in the diagram. The generator output is fed to a dc motor. By varying the generator field current, its output voltage will change. The speed of the controlled motor thus can be varied smoothly from zero to full speed.

Since control is achieved through the generator shunt field current, the control equipment is required only for small current values. A potentiometer or rheostat in the generator field circuit enables he variation of output voltage from zero to the full value and also in either direction. The controlled motor has a constant excitation. Its speed and direction are thus determined by the generator output.

PROCEDURE:

1. Connect the circuit as per circuit diagram.
2. Switch on the power supply.
3. Vary the generator field current.
4. Observe the voltage and speed control of the system.

OBSERVATION TABLE:

S.NO	FIELD CURRENT	VOLTAGE	SPEED
1.			
2.			
3.			

PRECAUTIONS:

1. Connection should be tight.
2. Connection should be neat and clean.
3. Observe the values carefully.

RESULT:

Speed control of DC motor using ward Leonard system is done successfully.