Subject Name: **Basic Electrical and Electronics Engineering**

Subject Code: **BT-104**

Course Outcomes:

After completion of this course student will be able to

CO1: understand the basic concepts of core electrical engineering subject.

CO2: understand the electrical machines, power systems and basic electronics.

EXPERIMENT NUMBER 1

AIM

Perform experiment to verify Kirchhoff's Current Law and Voltage Law using two mesh circuit.

APPARATUS REQUIRED

Connecting leads
Digital Multi-meter
Kirchhoff's law kit

THEORY

Kirchhoff's Current Law

Kirchhoff's developed two laws for analysis of an interconnection of any number of circuit elements. The first law deals with the flow of current and is called Kirchhoff's current law (KCL). The law states that;

"The algebraic sum of current at any node of the circuit is equal to zero (0)"

In other words, it simply means that the total current entering a node must be equal to the total current leaving a node. Consider the case of T-Network as shown in figure 1(a).

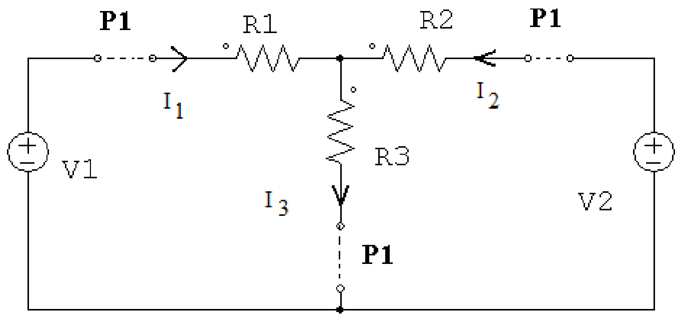


Fig 1(a)

R1= 1kΩ
R2 = 15 kΩ
R3 = 15 kΩ

The direction of incoming current to a node being positive, the direction of outgoing current should be taken as negative.

Thus,

$\sum I = 0$

Or $I_1 + I_2 - I_3 = 0$

Or $I_1 + I_2 = I_3$

i.e. Incoming current = Outgoing current

PROCEDURE FOR KCL

- Connect the circuit shown in figure.1. In this case ammeter will measure total current I.
- Connect the ammeter in series with resistance R_1 to measure current I_1 as shown in *figure1 (a)*.
- Similarly connect the ammeter in series with resistance R_2, R_3 to measure branch current I_2, I_3 respectively.
- Put the value of V_1, V_2, I, I_1, I_2, I_3, R_1, R_2, R_3 in equations & verify each equation.

OBSERVATION TABLE

Branch current I_1 (A/mA)	Branch current I_2 (A/mA)	Branch current I_3 (A/mA)

CALCULATION

$I_1 + I_2 + I_3 = 0$

RESULT

Practical and theoretical values are verified

Kirchhoff's Voltage Law

The second law deals with the conservation of potential and is called Kirchhoff's Voltage Law (KVL). And it state that

"*The algebraic sum of voltage (or voltage drop) in any closed path of network that is traversed in a single direction is zero (0)*".

The algebraic sum of the product of current & resistance in each of the conductor in any closed path (or mesh) in a network plus the algebraic sum of e.m.f. in the path is zero (0).

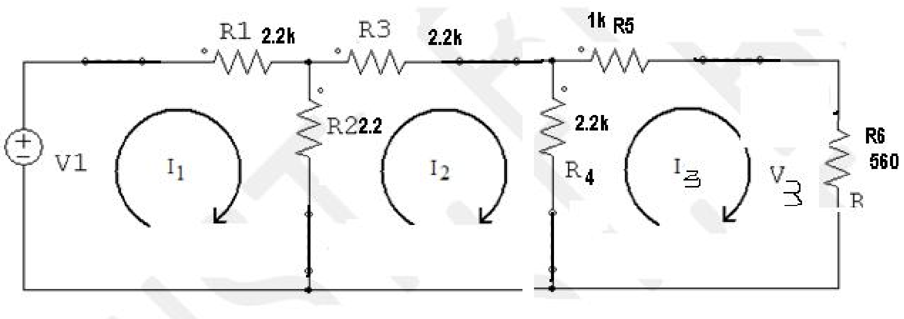


Fig 1(b)

Or $\sum IR + \sum$ e.m.f $= 0$………………round a mesh.

i.e $\sum E = \sum$ IR drop ....in the closed loop

The algebraic sum is the sum which takes into account the polarities of the voltage. If we start from a particular junction & go round the mesh till we come back to the starting point, then we must be at the same potential, with which we started. Hence, it means that all the source of emf met on the way must necessarily be equal to the voltage drops in the resistances, every voltage given its proper sign (+/-).

According to KVL;

For mesh 1;

$$\sum V = \sum IR$$

i.e. $V_1 = I_1R_{1+} I_1R_2(I_1-I_2) = 0$

For mesh 2;

$$\sum V = \sum IR$$

i.e. $R_3 I_2+ R_4 (I_2-I_3)+ R_2(I_2-I_1) = 0$

For mesh 3;

$$\sum V = \sum IR$$

i.e. $R_5 I_3+ R_6 I_3+R_4 (I_3-I_2) = 0$

OBSERVATION TABLE

Branch current I_1 (A/mA)	Branch current I_2 (A/mA)	Branch current I_3 (A/mA)	Voltage across R1	Voltage across R2	Voltage across R3	Voltage across R4	Voltage across R5	Voltage across R6

PROCEDURE FOR KVL

Connect the circuit shown in figure.1. Measure the values of V_1 and V_2.
Connect the ammeter in series with resistance R_1 to measure current I_1 as shown in *figure 1(b)*.
Similarly connect the ammeter in series with resistance R_2, R_3 to measure branch current I_2, I_3 respectively.
Put the value of V_1, V_2, I_1, I_2, I_3, R_1, R_2, and R_3 in equations & verify each equation.

CALCULATION

For mesh 1; $V_1 = I_1R_1 + I_1R_2(I_1-I_2) = 0$

For mesh 2; $R_3 I_2 + R_4(I_2-I_3) + R_2(I_2-I_1) = 0$

For mesh 3; $R_5 I_3 + R_6 I_3 + R_4(I_3-I_2) = 0$

RESULT

Practical and theoretical values are verified

PRECAUTIONS

- Make connection before starting the experiment, or switch on the supply.
- Make sure all connections are correct and proper.
- Avoid loose connection in the circuit.
- Record observed values carefully.

EXPERIMENT NUMBER: 2

AIM

Perform experiment to Verify Thevenin's Theorem using Trainer kit.

APPARATUS REQUIRED

- Digital Multimeter
- Power supply
- Thevenin's Theorem kit
- Connecting leads

THEORY

Statement of Thevenin's Theorem:

"Any two terminal bilateral linear networks can be replaced by an equivalent circuit consisting of a voltage source and a series resistor."

Explanation

Let us consider a simple DC circuit as shown in figure 1(a). We are to find I_L by Thevenin's theorem.

In order to find the equivalent source, R_L is removed (figure 1(b)) and $V_{o/c}$ is calculated.

$$V_{o/c} = I\ R_3 = V_S R_3/(R_1+R_3)$$

Next, to find the internal resistance of the network (Thevenin's resistance or equivalent resistance) in series with $V_{o/c}$, the voltage source is removed (or deactivated) by a short circuit or replacing by their internal resistance. As shown in figure 1(c)

$$R_{Th} = R_2 +[\ R_1R_3(R_1+R_3)]$$

As per Thevenin's Theorem, the equivalent circuit being figure 1(c)

$$I_L = V_{o/c} / (R_{Th} + R_L)$$

CIRCUIT DIAGRAM

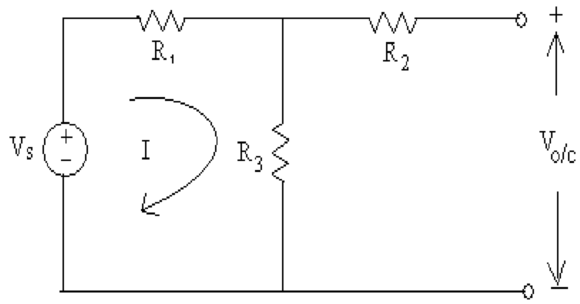


figure 1(b)

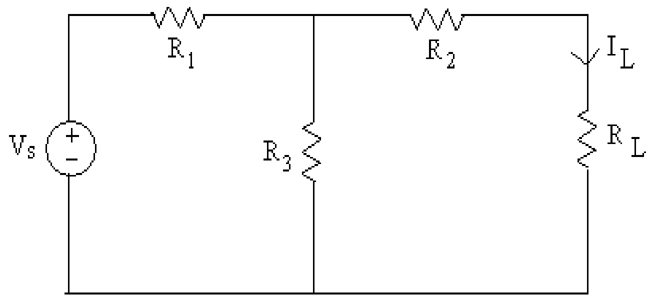


figure 1(a)

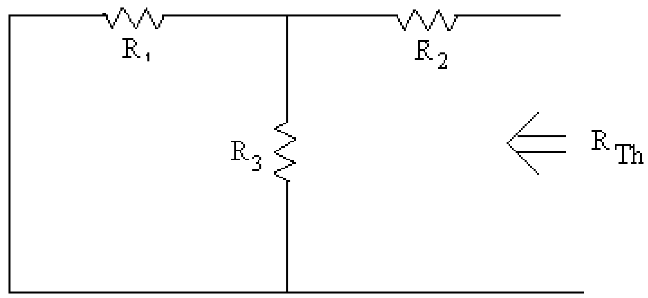


figure 1(c)

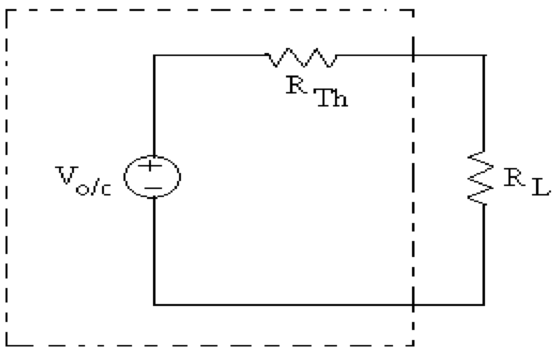


figure 1(d)

PROCEDURE

1. Remove the load resistance
2. Calculate the voltage across the resistance which will give you V_{th} . Deactivate all the sources as, short circuit the voltage source and open circuit the current source or replace by their internal resistance.
3. Now calculate the equivalent resistance from the load side, this will give you R_{th}
4. Draw thevenin's equivalent circuit by the calculated parameters i.e Vth, Rth and connect the load resistance that you have removed earlier(connect all these in series)
5. Calculate the load current (I_L or I_{TH}) by the formula and verify by measuring it from your multimeter across load resistance.

$$I_{Th} = V_{Th} / (R_{Th} + R_L)$$

OBSERVATION TABLE

S.No.	Supply voltage (V)	R_L	Thevenin's Voltage V_{Th}	Equivalent Resistance R_i or R_{Th}	I_{Th}
1					

RESULT:

The value of the calculated value of load current through R_L obtained by using Thevenin's Theorem and that obtained via Thevenin's equivalent circuit are found to be same and hence the Thevenin's Theorem is verified.

PRECAUTIONS

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connections are correct or proper.
3. Avoid loose connection in the circuit.
4. Record observed value carefully.

EXPERIMENT NUMBER: 3

AIM:

Perform experiment to Verify Superposition Theorem using Trainer kit.

APPARATUS REQUIRED:

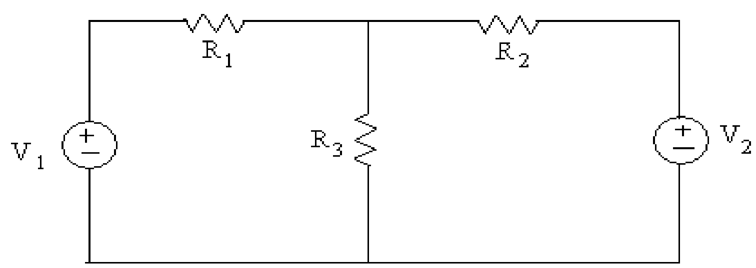
- Digital Multimeter
- Superposition Theorem kit
- Power supply
- Connecting wires

THEORY

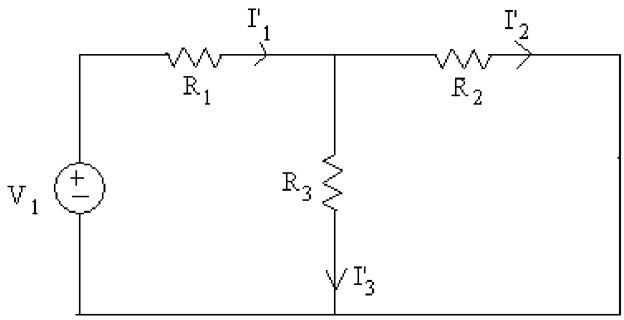
The theorem finds use in solving a network where two or more sources are present and connected in series and in parallel. The statement for the Superposition Theorem can be given as;

Statement of Superposition Theorem- *"If a number of voltage or current sources are acting simultaneously in a linear network, the resultant current or voltage in any branch is the algebraic sum of the currents and voltage that would be produced in it, when each source acts alone and replacing all other independent sources by their internal resistances."*

Explanation:



In this figure, to apply Superposition Theorem, let us first take the source V_1 alone at first replacing V_2 by short circuit.

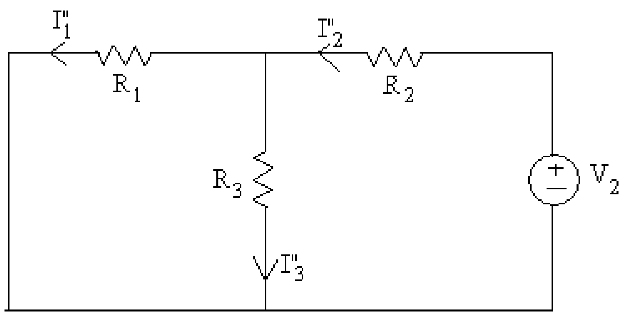


Here, $I_1' = V_1 / [R_2R_3/ (R_2+ R_3) + R_1]$

$I_2 = I_1'R_3/ (R_2+R_3)$

And $I_3' = I_1' – I_2'$

Next, removing V_1 by short circuit let the circuit be energized by V_2 only.



Here, $I_2'' = V_2 / [R_1R_3 / (R_1+R_3) + R_2]$

And, $I_1'' = I_2''R_3/(R_1+R_3)$

Also, $I_3'' = I_2'' – I_1''$.

As per Superposition theorem,

$I_3 = I_3'+ I_3''$

$I_2 = I_2' – I_2''$

$I_1 = I_1' –I_1''$.

PROCEDURE:

1. Set voltages V_1 and V_2 with the help of DC supply.
2. Consider the voltage source V1 and remove the other voltage sources by short circuiting them or replace them by their internal resistance if given.
3. Calculate equivalent resistance (Req) from the voltage source side that you have considered.
4. Using Ohm's law calculate the current through it, I_1'= V1/Req.
5. Using current division formula calculate the current I_2' and I_3'

6. Similarly now consider another voltage source and repeat the procedure of step no.2 to step no.5 and use the notation of current as I1'',I2'',I3''.
7. Using sigh convention calculate I1, I2, I3.
8. Measure the branch current by multimeter and observe that both calculated and measured values are same.

OBSERVATION TABLE:

S.NO	V_1	V_2	I_1	I_2	I_3

RESULT:

As we find that the current in the desired branch due to number of sources in the network is equal to the algebraic summation of current in the branch, taking individual source at a time. And thus we find that the Superposition theorem is true and verified.

PRECAUTIONS:

1. Make connection before starting the experiment, or switching on the supply.
2. Make sure all connection is correct and proper.
3. Avoid loose connections in the circuit.
4. Record observed values carefully.

EXPERIMENT NUMBER 4

AIM

Perform experiment to measure Active and Reactive power consumed by single phase inductive load while connected to single phase AC supply.

APPARATUS

S.No.	Apparatus	Type	Range	Quantity
1	Auto transformer	Single phase	10 A, 270 V	1
2	Wattmeter	Dynamometer	10 A, 250 V	1
3	Ammeter	MI	0-10 A	1
4	Voltmeter	MI	0-250 V	1
5	Resistive load	-	15 Ω, 5 A	1
6	Inductive load	-	Auto transformer	1
7	Connecting leads	-	-	20

THEORY

The power which is actually consumed or utilized in an ac circuit is called *true power or active power.*
As power is consumed only in resistance and a pure inductor and a pure capacitor do not consume any power in a cycle. Since in a half cycle whatsoever power is received from the source by inductor and capacitor and the same amount of power is returned to the source. This power, which flows back & forth or reacts upon itself, is called reactive power. It does not do any useful work in circuit.

Therefore, True power or active power = voltage × current in the phase with voltage

$$= V \times I \cos Ø$$

$$= V I \cos Ø \text{ Watt}$$

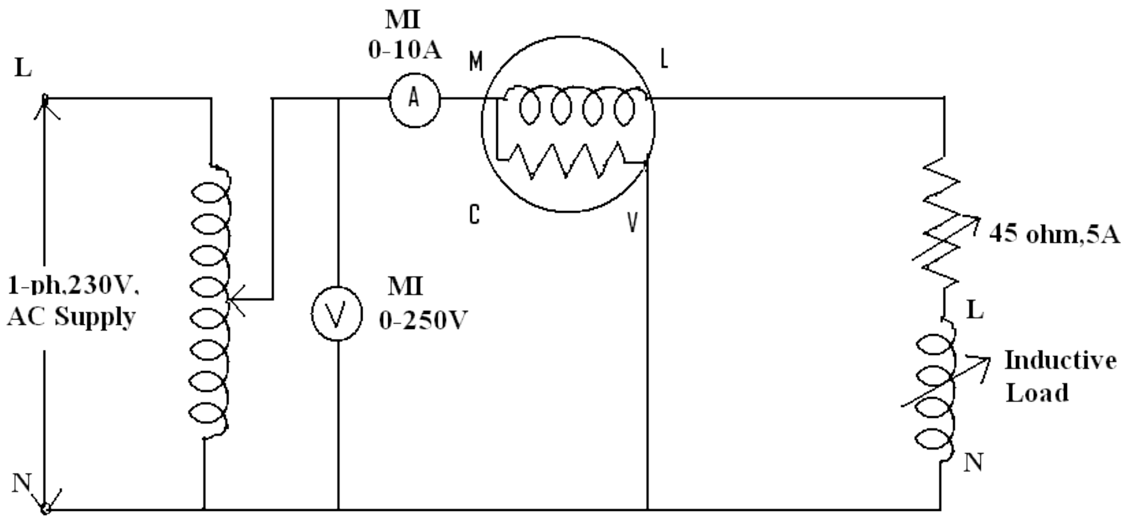
And reactive power = Voltage × current 90 out of phase with voltage

$$= V \times I \sin Ø$$

PROCEDURE

1. Connect the instruments, Autotransformer and load shown in fig. and set up to autotransformer to zero position.
2. Ensure the load end variac (variable inductor) and rheostat is at the maximum inductance position.
3. Switch on the supply and adjust the autotransformer till suitable voltage (nominal 220 V).
4. Note that the current is still zero in the circuit; take down the first readings from voltmeter, ammeters and watt meters.
5. Now gradually vary the inductance of the load end variac till ammeter reads 1 Amp, take down the readings of all the measuring instruments.
6. Repeat the step 5 for 2Amp, 3 Amp , 4 Amp, and enlist the readings.
7. Vary the rheostat for the last readings and take down the last reading for 4.5 Amp.
8. Calculate the values of power factor and reactive power for the observations taken.

CIRCUIT DIAGRAM



Power measurement in single phase ac. circuit

OBSERVATION

S.No.	Voltmeter readings V in volt	Ammeter reading I in amp.	Wattmeter reading P in watt	cosΦ	Reactive power Q = VISinØ

CALCULATION

Calculate the value of power factor CosØ from different readings as
CosØ = wattmeter reading / (voltmeter reading × ammeter reading)
Calculate the value of reactive power as $Q = VI \sin Ø = VI (1- \cos^2 Ø)^{1/2}$

RESULT
Power at different voltages is as shown in observation table and conclusion is that power varies as square of the applied voltage.

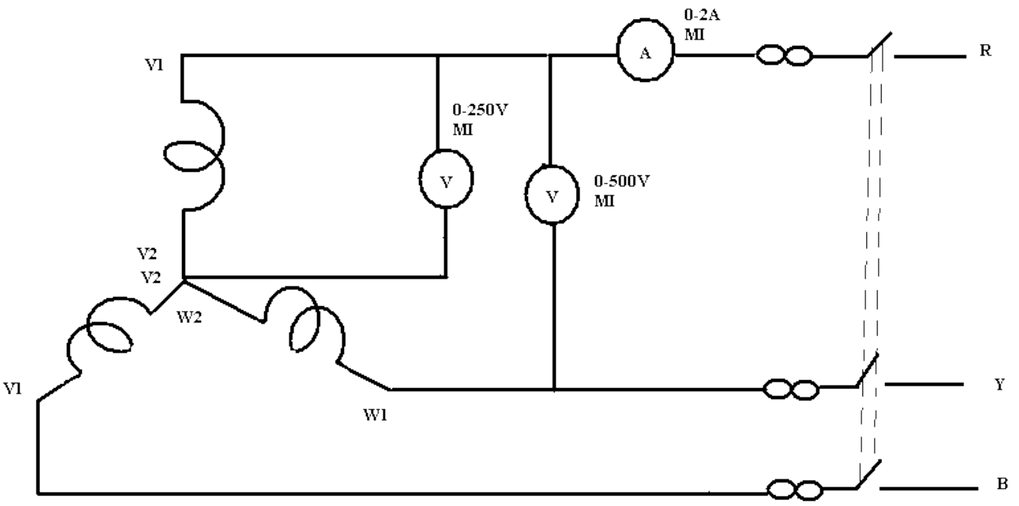
EXPERIMENT NUMBER 5

AIM
To verify the relationship in Star and Delta connected three-phase AC system.

INSTRUMENTS REQUIRED

S.No.	Name	Range	Type	Quantity
1.	Voltmeter	0-500A	MI	1
2.	Voltmeter	0-250A	MI	1
3.	Ammeter	0-2A	MI	2

THEORY
STAR CONNECTION



Line Voltage = Voltage between any two line terminals,

$$V_L = V_{RY} = V_{RB} = V_{BY}$$

Phase Voltage = Voltage between any one line & neutral,

$$V_{ph} = V_{RN} = V_{BN} = V_{YN}$$

Line & phase current is equal in case of star connection,

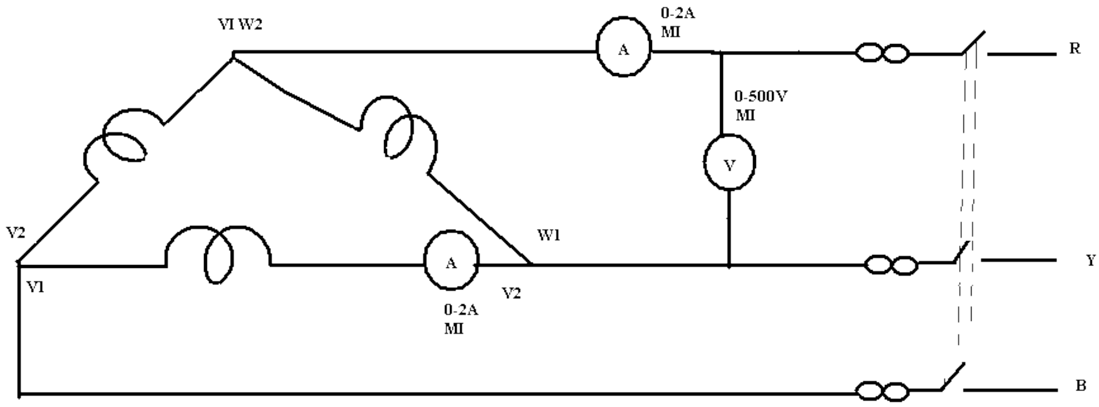
$$V_{RY} = V_{RN} - V_{YN}$$

$$= V_{RN} + (- V_{YN})$$

$$= (V_{RN}^2 + V_{YN}^2 + 2 V_{RN} . V_{YN} \text{ Cos } 60°)^{1/2}$$

$$= (V_{ph}^2 + V_{ph}^2 + 2 V_{ph} . V_{ph} * ½)^{1/2} = \sqrt{3} \ \mathbf{V_{ph}}$$

DELTA CONNECTION



DELTA CONECTION

Line Current - Current coming from the line terminal.

$I_L = I_R = I_B = I_Y$

Phase current – It is the current flowing through the load connected between two terminals.

$I_{ph} = I_{RY} = I_{YB} = I_{BR}$

$I_R = I_{RY} - I_{BR}$

$= I_{RY} + (-I_{BR})$

$= (I_{RY}^2 + I_{BR}^2 + 2I_{RY} . I_{BR} \text{Cos } 60°)^{1/2}$

$= (I_{RY}^2 + I_{BR}^2 + 2I_{RY} . I_{BR} * ½)^{1/2}$

$= \sqrt{3} \quad I_{PH}$

OBESERVATION TABLE

Connection	I_L	I_{ph}	V_L	V_{ph}
Star				
Delta				

RESULT

Ratio of V_L / V_{ph} = ---------------- for Star Connection

Ratio of I_L / I_{ph} = ----------------for delta Connection

EXPERIMENT NO.6

AIM

To perform O.C. & S.C. Test on 1-Ph Transformer and determine

-Equivalent circuit parameters,
-Efficiency and Voltage regulation

APPARATUS

S.No.	Name	Range	Type	Quantity
1.	Single Phase auto Transformer	0-270 V, 10A	-	1
2.	Ammeter	0-15A	MI Type	1
3.	Ammeter	0-2A	MI Type	1
4.	Voltmeter	0-300V,	MI Type	1
5	Voltmeter	0-30V,	MI Type	1
6	Wattmeter	75V, 15A	Dynamometer	1
7	Wattmeter	200V, 2.5A	Dynamometer	1

NAME PLATE DETAILS OF TRANSFORMER

Rating - ……1-ø, 230V, 1 kVA

THEORY

This test is carried out to determine the No Load or core loss or iron loss. No load current I_o which used to determine the No lad parameter that is $R_ø$ & $X_ø$ of the transformer.

This test is usually carried out on the low voltage of the transformer. Wattmeter, Voltmeter & Ammeter is connected in low voltage winding (primary). The primary winding is connected to the normal rated voltage V1 & frequency as given on the plate of the transformer. The secondary side is kept open or connected to a voltmeter V. Since the secondary is open, the current drawn by the primary is no load current I_o measured by the Ammeter A, The value of no load current I_o is very small usually 2 to 10 % of the rated full load current. Thus the copper loss in the primary are negligibly small and no copper loss in the secondary because it is open therefore wattmeter reading W_o only represent the core loss or iron loss for all practical purposes. These core losses are constant at all loads. The voltmeter V if connected across secondary side measure the secondary induced voltage V2.

The ratio of voltmeter reading, V_2/V_1gives the transformation ratio of the transformer.

Let the wattmeter reading = Wo

Voltmeter reading = V_1

Ammeter reading= Io

Then, iron losses of the transformer

Pi = $W_ø$ and V_1.Io.CosǾo= W_o

No load power factor, CosǾo = $W_ø$/(V_1.I_o)

Working component,

$I_w = W_0/V_1$ ($I_w = I_o \cos\phi_o$)

Magnetizing component $I_m = \sqrt{(I_o^2 - I_w^2)}$

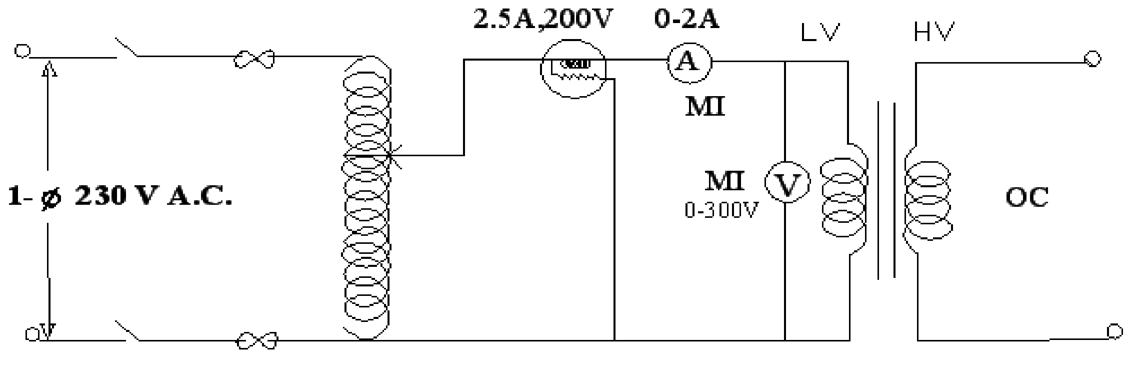
No load parameter,
Equivalent exciting resistance, $R_o = V_1/I_w$
Equivalent exciting reactance $X_o = V_1/I_m$
The iron losses measured by this test are required for the calculation of efficiency of the transformer.

PROCEDURE

For Open circuit test

1. Connect the circuit as shown in figure and setup the auto transformer to zero position
2. Adjust the supply voltage transformer with the help of auto transformer to 230V with secondary winding open.
3. Record the ammeter, voltmeter and wattmeter readings.
4. Vary the supply voltage with the help of the transformer and enter the reading of the observation table.
5. Switch off the supply.

CIRCUIT DIAGRAM



Open Circuit Test

OBSERVATION

For Open circuit test.

S.No.	Voltmeter Reading (Vo) in volts	Ammeter Reading (Io) in amp	Wattmeter Reading (Wo) in watt

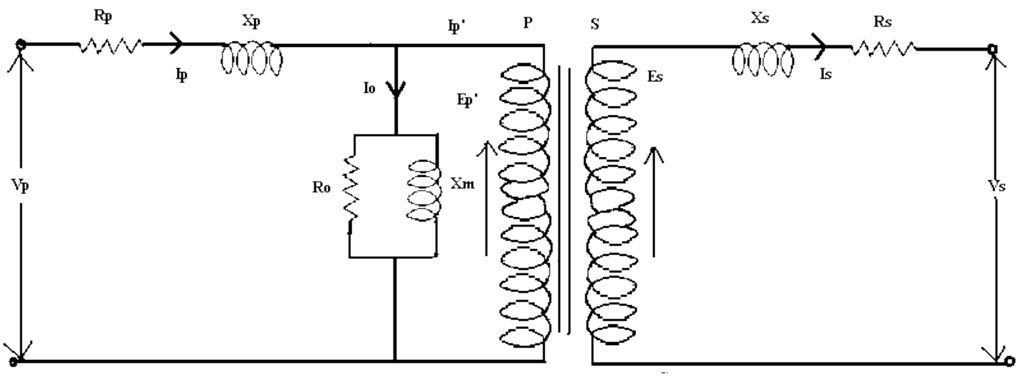
CALCULATIONS

1. from O.C.Test

No load power factor (CosǾo) = $W_o/V_1.I_o$ =……………
SinǾo = ………….
I_w = Io CosǾo =……..Amp
I_m = Io SinǾo = ……..Amp
Then
$R_o = V_o/I_w$ = ………..Ω, $X_o = V_o/I_m$ = ……………. Ω

EQUIVALENT CIRCUIT

With the help of above parameters we can draw the equivalent circuit as shown



EQUIVALENT CIRCUIT OF TRANSFORMER

RESULTS
Equivalent circuit parameters of single phase transformer are determined.

<u>Short Circuit Test</u>

APPARATUS

S no.	Name	Range	Type	Quantity
1.	Single Phase auto Transformer	0-270 V, 10A	-	1
2.	Ammeter	0-15A	MI Type	1
3.	Ammeter	0-2A	MI Type	1
4.	Voltmeter	0-300V,	MI Type	1
5	Voltmeter	0-30V,	MI Type	1
6	Wattmeter	75V, 15A	Dynamometer	1
7	Wattmeter	200V, 2.5A	Dynamometer	1

NAME PLATE DETAILS OF TRANSFORMER
Rating - ……1-ø, 230V, 1 kVA

THEORY

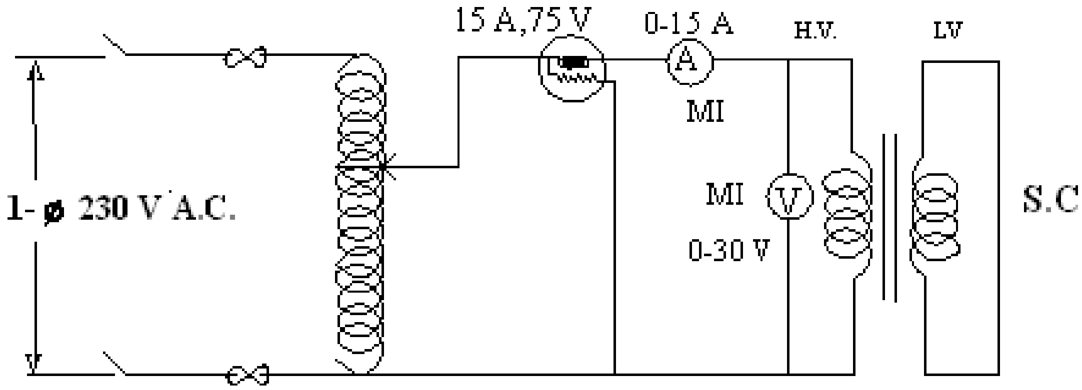
This test is carried out to determine the full load copper loss. In this experiment LV side is short circuited and instruments are connected in H.V side. Reduced voltage 2-12 % of rated is applied at the primary which is sufficient to calculate rated short circuit current in both the winding at the rated current.
Actually the wattmeter records the total losses including the core losses in the transformers but since the core loss which (depends upon the applied voltage) is very less as compared to copper loss which (depends upon the load current) in case of short circuit. So it can be neglected and the wattmeter reading is assumed to be copper loss only.

PROCEDURE

For Short circuit test

1. Connect the circuit as shown in figure and setup the auto transformer to zero position.
2. Switch on the supply and apply the voltage gradually with the secondary winding terminal short circuited. Keep in mind that only 10 to 12% of the rated voltage is sufficient to circulated full rated current in the short circuited winding.
3. Adjust the input voltage to obtain 50%,75% and 125% rated full load current in secondary.
4. Record the instrument reading in the observation table.

CIRCUIT DIAGRAM



Short Circuit Test

OBSERVATION

For Short circuit Test

S.No.	Voltmeter Reading (Vsc) in volts	Ammeter Reading (Isc) in amp	Wattmeter Reading (Wsc) in watt

CALCULATIONS

from S.C.Test

Total impedance referred to the H.V.Side

Zo_2 = Vsc/Isc =………….. Ω

Total resistance referred to the HV Side

$Ro_2 = Wsc/Isc^2 = \ldots\ldots\ldots\ \Omega$

$Xo_2 = \sqrt{(Z_{02}^2 - R_{02}^2)}$

Total Resistance and Reactance reffered to LV Side

$R_{01} = R_{02} \times (N_1/N_2)\ ) = \ldots\ldots\ldots\ \Omega$

And $Xo_1 = Xo_2\ (N_1/N_2)$

Efficiency Calculation

Efficiency at any load

Iron loss = Wi = watts from O.C.Test

Full load copper loss = watts from S.C.Test

Let the load power factor be CosǾo

S = Full load VA

X= Any load VA /Full load VA.

ή at any load = $\mathbf{S \times X \times Cos\acute{\O}o / (S \times X \times Cos\acute{\O}o + Wi + X^2)}$

Regulation Calculation

% Regulation = ϵr CosǾo ± ϵx SinǾo + for lagging p.f. - for leading p.f.

Where ϵr = % Resistance = $(I1Ro_1 \times 100)/E_1 = (I_2Ro_2 \times 100)/E_2$

&

ϵx = % Reactance= $(I_1\ Xo_1 \times 100)/E_1 = (I_2Xo_2 \times 100)/E_2$

Result:

The efficiency of transformer is _______________

The regulation calculated is ________________

EXPERIMENT NO.7

AIM

To Study the various logic gates and to verify their truth tables.

APPARATUS

Logic Gate Kit, Patch chords, output indicator, Dual mode power supply.

THEORY

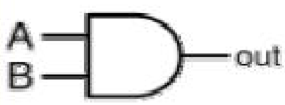
The electronic circuitries in a variety of applications needs to be equipped with some basic logic so as to obtain an automated operation and control, for this purpose the digital Logic devices are explicitly used in all real time systems today. These Logic devices called Logic gated can perform basic arithmetic operations and their combinations are required for to define a real time logic.

These Logic Gates are classified into Basic Logic Gates and Universal Gates. The Basic logic gate family is constituted by (1) And Gate (2) Or Gate (3) Not Gate; while the universal logic gates are so called because they can realise basic logic gates when connected in a definite order.

AND Gate

The And Gate is the logic gate that can perform logical multiplication of two or more binary inputs. And is written as A.B, and read as "A" and "B". The symbol and Truth Table for And Gate is given below.

AND



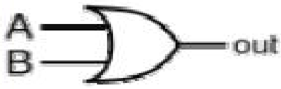
INPUT		OUTPUT
A	B	A AND B
0	0	0
0	1	0
1	0	0
1	1	1

OR Gate

The OR operation is the logical addition of two or more binary inputs. The operation is written as A+B and read as "A" or "B". The symbolic representation and truth table are as

shown below;

OR

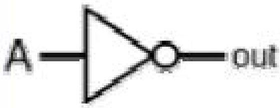


INPUT A	INPUT B	OUTPUT A OR B
0	0	0
0	1	1
1	0	1
1	1	1

Not Gate

The NOT gate is also called Logic Inverter, defined as “Not A” or $\bar{A}$. The ouput of a NOT gate is the invert of the input, **the Truth table and the symbol for the same is given below.**

NOT

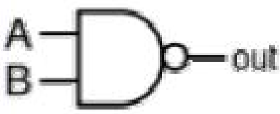


INPUT A	OUTPUT NOT A
0	1
1	0

Nand Gate

The Nand Gate is the logical combination of AND gate followed by an inverter. The output states of a Nand gate are just opposite to those of an and gate , and are shown below.

NAND



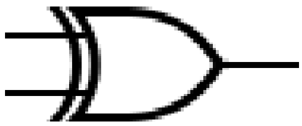
INPUT A	INPUT B	OUTPUT A NAND B
0	0	1
0	1	1
1	0	1
1	1	0

Nor Gate

The Nor Gate is the logical combination of OR gate followed by an inverter. The output states of a Nor gate are just opposite to those of a OR gate , The truth table and symbol are as shown.

XOR

XOR



INPUT		OUTPUT
A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0

XNOR

XNOR

INPUT		OUTPUT
A	B	A XNOR B
0	0	1
0	1	0
1	0	0
1	1	1

PROCEDURE

1. Connect the input binaries and the output indicator to the "G" logic gate input and output terminals respectively.
2. Switch on the Kit and record the reading.
3. Change the inputs and record readings in the order shown in truth table.
4. Repeat the procedure for the rest of the logic gates.
5. Record the readings and tabulate the result in observation table
6. Switch off the supply and remove the patch chords.

OBSERVATION TABLE

Gate	A	B	C
AND	0	0	
	0	1	
	1	0	
	1	1	
OR	0	0	
	0	1	
	1	0	
	1	1	
NOT	0		
	1		
NOR	0	0	
	0	1	
	1	0	
	1	1	
NAND	0	0	
	0	1	
	1	0	
	1	1	
XOR	0	0	
	0	1	
	1	0	
	1	1	
	1	1	
XNOR	0	0	
	0	1	
	1	0	
	1	1	

RESULT

The various Logic Gates are studied and their Truth Tables are verified.

EXPERIMENT NUMBER 8

AIM

To study and plot VI characteristics of semiconductor diodes.

APPRATUS REQUIRED

S.NO.	NAME	QUANTITY
1	PN junction diode practical kit	01
2	Zener diode practical kit	01
3	Digital multimeter	02
4	Power supply	12V ac
5	Patch cords	5 to 10

THEORY

SEMICONDUCTOR

The substance like carbon, silicon and germanium etc. whose electrical conductivity lies in between the conductor and insulator are known as semiconductor.

A pure silicon crystal or germanium crystal is known as an intrinsic semiconductor. There are not enough free electron and holes in an intrinsic semi conductor to produce a usable current. The electrical action of these can be modified by doping means adding impurity atoms to a crystal to increase either the number of free holes or no of free electrons. When a crystal has been doped, it is called a extrinsic semi conductor. They are of two types.

N-TYPE SEMICONDUTOR

N- Type semiconductor are a type of extrinsic semiconductor where the dopant atoms of pentavalent property are capable of providing extra conductor electrons to the host material (e.g. phosphorus in silicon) . This create an excess of negative (n-type) electron charge carries. N-type semiconductor having free electrons as majority carries.

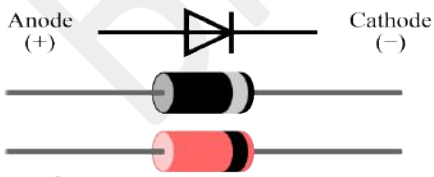
P-TYPE SEMICONDUCTOR

p-type semiconductor are a type of extrinsic semiconductor where the dopant atoms of trivalent property are capable of providing a vacant place created left behind by the electron.(e.g. boron in

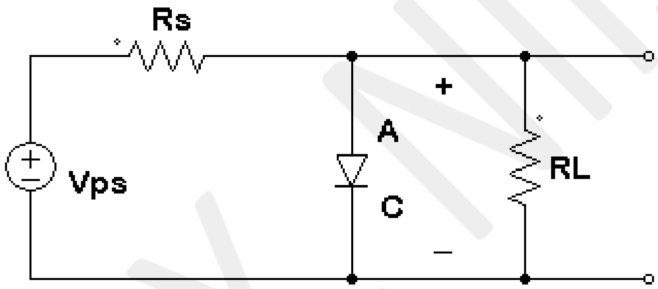
silicon) this create an excess of positive (p-type) charges carriers known as a hole . P-type semiconductor having free holes as majority carriers.

P-N JUNCTION DIODE

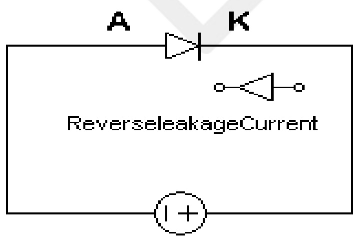
A **PN** junction is formed by joining p –type an n-type semiconductor together in very close contact. The term junction refers to the boundary interface where the two regions of the semiconductor meet. If they were constructed of two separate pieces this would introduce a grain boundary, so p- n junction are created in a single crystal of semiconductor by doping, for example by ion implantation, diffusion of dopants. **PN** Junction is elementary 'building blocks' of almost all semiconductor electronic devices such as diodes, transistor, solar cells, LEDs, and integrated circuit. They are the active site where the electronic action of the device takes place. For example, a common type of transistor, the bipolar junction transistor, consists of two p-n junctions in series, in the form of n-p-n or p-n-p. The symbol of diode is shown below. The terminal connected to p-layer is called anode (A) and the terminal connected to n-type is called cathode (k)



CIRCUIT DIAGRAM



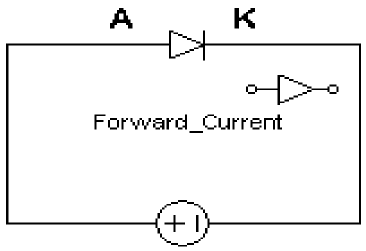
REVERSE BIAS



If positive terminal of dc source is connected to cathode and negative terminal is connected to anode, the diode is called reverse biased. When the diode is reverse biased then the depletion region width increase, majority carriers' move away from the junction and there is no flow of current due to majority carriers but there are thermally produced electron hole pair also. If these electrons and holes are generated in the vicinity of junction then there is a flow of current. The negative voltage applied to the diode will tend to attract the holes thus generated and repel the electrons. At the same time, the positive voltage will attract the electrons towards the battery and repel the holes, this will cause current to flow in the circuit. This current is usually very small. Since this current is due to majority carriers and these number of majority carriers are fixed at a given temperature therefore, the current is almost constant known as reverse saturation current ICO.

In actual diode, the current is not almost constant but increase slightly with voltage. This is due to surface leakage current. The surface of diode follows ohmic law (V=IR) the resistance under reverse bias condition is very high 100k to mega ohms. When the reverse voltage is increased, then at certain voltage, then breakdown to diode take place and it conduct heavily. This is due to avalanche or zener breakdown.

FORWARD BIAS

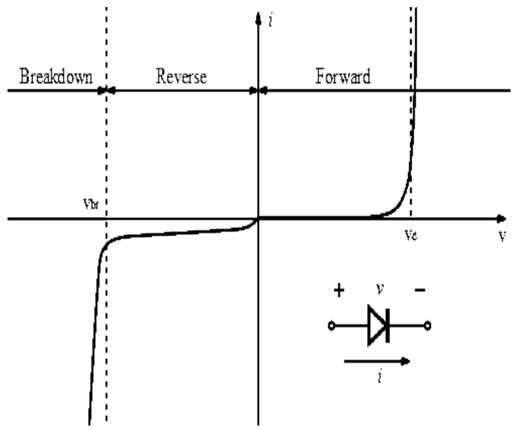


When the diode is forward bias, due to positive polarity at anode and negative at cathode respectively majority carriers are pushed towards junction, when they collide and recombination take place. Numbers of majority carriers are fixed in semiconductor. Therefore as each electron is eliminated at the junction, a new electron must be introduced, this come from battery. At the same time, one hole must be created in p-layer. This is formed by extracting one electron from p-layer. Therefore there is a flow of carriers and thus flow the current.

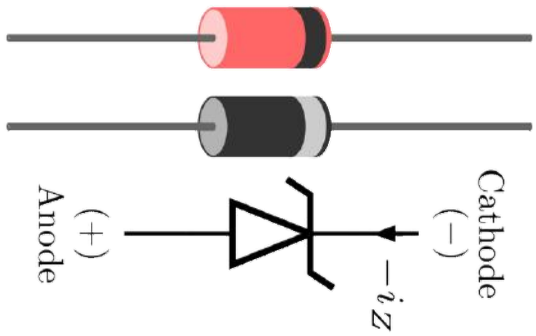
APPLICATION OF PN JUNCTION DIODE

1. As a rectifier.
2. For meter protection.
3. For wave shaping.

CHARACTERISTICS OF PN DIODE



ZENER DIODE



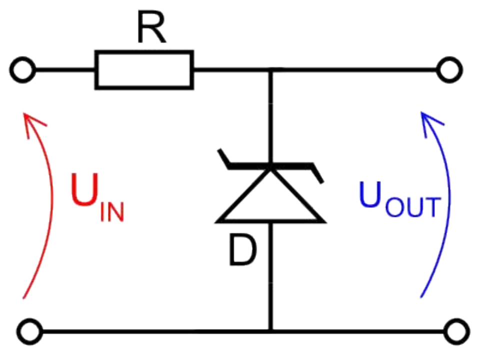
A zener diode is a type of diode that permit current not only in the forward direction like normal diode, but also in reverse direction if the voltage is larger then break down voltage known as “zener knee voltage” or “ zener voltage . The device was named after Clarence zener, who discovered this electrical property.

A conventional solid state diode will not allow significant current if it is reverse biased below its reverse breakdown voltage. When the reverse bias breakdown voltage is exceeded, a conventional diode is subject to high current due to avalanche breakdown. Unless this current is limited by circuitry, the diode will be permanently damaged. In case of large forward bias (current in the direction of arrow) , the diode exhibits a voltage drop due to its junction built-in voltage and internal resistance. The amount of the voltage drop depends on the semiconductor material and the doping concentrations.

The zener diode’s operation depend on the heavy doping of its p-n junction allowing electrons to tunnel fro the valence of the p-type material to the conductor band of the n-type material. In the atomic scale, this tunneling correspond to the transport of valence band electrons in to the empty conductor band states; as a result of the reduced barrier between these bands and high electric field that are induced due to the relatively high level of doping on both sides. The breakdown voltage can be controlled quit accurately in doping process. While tolerance with in 0.05% is available, the most widely used tolerance is 5% and 10%. Breakdown voltage for commonly available zener diode can vary widely from 1.2 volts to 200 volts.

When being used a voltage regulator, if the voltage across the load tries to rise then the zener takes more current. The increase in current through the resistor causes an increase in voltage dropped across the resistor. This increase in voltage across the resistor causes the voltage across the load to remain at its correct value. In a similar manner, if the voltage across the load tries to fall, then the zener takes less current. The current through the resistor and the voltage across the resistor both falls. The voltage across the load remains at its correct value.

CIRCUIT DIAGRAM



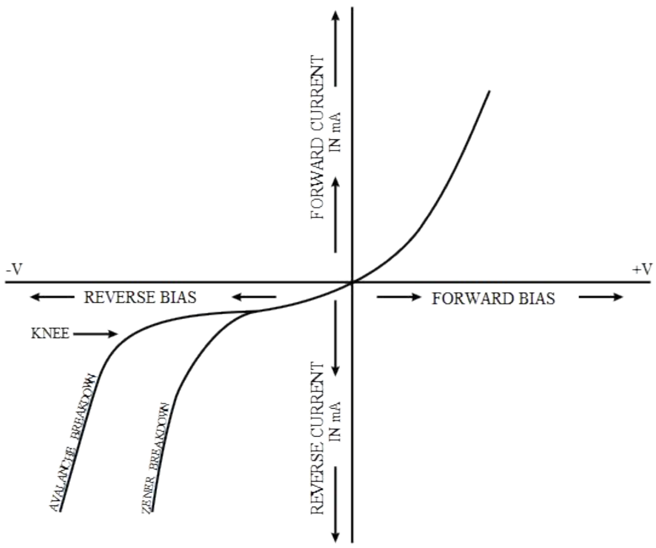
APPLICATION OF ZENER DIODE

It has two main applications.

- As a reference source, where the voltage across it is compared with another voltage.
- As shunt regulator to regulate the voltage across small circuit.
- As a voltage regulator, smoothing out any voltage variations occurring in the supply voltage across the load.

ZENER DIODE CHARACTERISTICS

It is a sharp breakdown voltage called zener voltage (vz) it can be operated in any of the three regions forward. Leakage and breakdown. But usually it operates in breakdown region. The voltage is almost constant over the operating region. During it will not burn as long as the external circuit limits the current flowing through it below the burn out value.



OBSERVATION TABLE

FOR PN DIODE				FOR ZENER DIODE			
S.NO.	**VDC**	**ID**	**VD**	**S.NO**	**VIN**	**IZ**	**VZ**

PROCEDURE

FOR PN JUNCTION DIODE

1. Connect main lead to AC supply
2. Connect 15 V DC to point A
3. Switch on power supply
4. Connect milli meter across point B and C for measurement of I_d.
5. Connect 2nd millimeter across diode AD take measurement of V_d.
6. Take the reading step by step by varying the power supply till 15V is reached.
7. Plot the graph between Id and Vd.

FOR ZENER DIODE

1. Connect main lead to AC supply.
2. Connect 15 V DC to point A.
3. Switch ON power supply.
4. Connect multimeter across point B and C for measurement of Iz.
5. Connect second multimeter across diode AD taking measurement of Vz.
6. Take the reading step by step varying the power supply till 15 V.
7. Plot the graph between Iz and Vz.

PRECAUTION

Handle all the apparatus carefully

Connect all components as per circuit diagram.

All connection should be tight

Be carefully about power supply it should be under digital range

1. Take observation very carefully

RESULT

Hence the VI characteristics of PN and Zener diode are studied.

EXPERIMENT NO.7

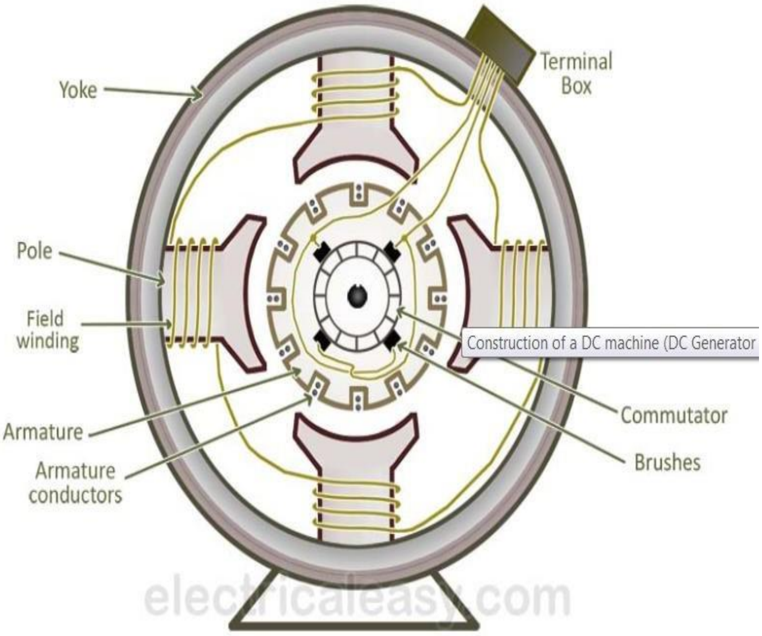
AIM

Study of construction and working principle of DC machine, 3-Phase Induction Motor, Synchronous Machine and Single phase induction machine.**DC Generator.**

A dc generator is an electrical machine which converts mechanical energy into direct current electricity. This energy conversion is based on the principle of production of dynamically induced emf. The following section outlines basic construction and working of a DC generator.

Construction of a DC Machine:

Note: A DC generator can be used as a DC motor without any constructional changes and vice versa is also possible. Thus, a DC generator or a DC motor can be broadly termed as a DC machine. These basic constructional details are also valid for the construction of a DC motor. Hence, let's call this point as construction of a DC machine instead of just 'construction of a dc generator'.


Terminal Box
Yoke
Pole
Field winding
Construction of a DC machine (DC Generator
Commutator
Armature
Armature conductors
Brushes
electricaleasy.com

Armature core (rotor)

The above figure shows constructional details of a simple **4-pole DC machine**. A DC machine consists of two basic parts; stator and rotor. Basic constructional parts of a DC machine are described below.

1. **Yoke:** The outer frame of a dc machine is called as yoke. It is made up of cast iron or steel. It not only provides mechanical strength to the whole assembly but also carries the magnetic flux produced by the field winding.
2. **Poles and pole shoes:** Poles are joined to the yoke with the help of bolts or welding. They carry field winding and pole shoes are fastened to them. Pole shoes serve two purposes; (i) they support field coils and (ii) spread out the flux in air gap uniformly.
3. **Field winding:** They are usually made of copper. Field coils are former wound and placed on each pole and are connected in series. They are wound in such a way that, when energized, they form alternate North and South poles
4. **Armature core:** Armature core is the rotor of a dc machine. It is cylindrical in shape with slots to carry armature winding. The armature is built up of thin laminated circular steel disks for reducing eddy current losses. It may be provided with air ducts for the axial air flow for cooling purposes. Armature is keyed to the shaft.
5. **Armature winding:** It is usually a former wound copper coil which rests in armature slots. The armature conductors are insulated from each other and also from the armature core.

Armature winding can be wound by one of the two methods; lap winding or wave winding. Double layer lap or wave windings are generally used. A double layer winding means that each armature slot will carry two different coils.

6. **Commutator and brushes:** Physical connection to the armature winding is made through a commutator-brush arrangement. The function of a commutator, in a dc generator, is to collect the current generated in armature conductors. Whereas, in case of a dc motor, commutator helps in providing current to the armature conductors. A commutator consists of a set of copper segments which are insulated from each other. The number of segments is equal to the number of armature coils. Each segment is connected to an armature coil and the commutator is keyed to the shaft. Brushes are usually made from carbon or graphite. They rest on commutator segments and slide on the segments when the commutator rotates keeping the physical contact to collect or supply the current.

Commutator

CONSTRUCTION OF AC MACHINES (THREE PHASE INDUCTION MOTOR)

The three phase induction motor is the most widely used electrical motor. Almost 80% of the mechanical power used by industries is provided by three phase induction motors because of its simple and rugged construction, low cost, good operating characteristics, the absence of commutator and good speed regulation. In three phase induction motor, the power is transferred from stator to rotor winding through induction. The induction motor is also called a synchronous motor as it runs at a speed other than the synchronous speed.

Like any other electrical motor induction motor also have two main parts namely rotor and stator.

Stator: As its name indicates stator is a stationary part of induction motor. A stator winding is placed in the stator of induction motor and the three phase supply is given to it.

Rotor: The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft.

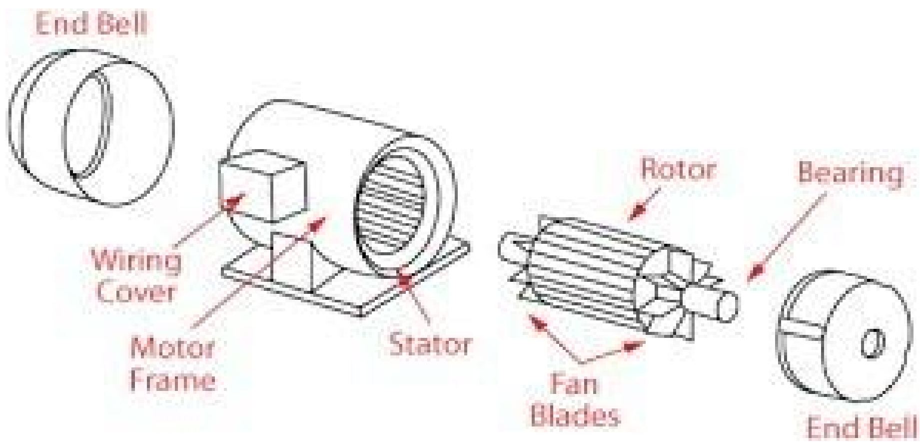
The rotor of the three phase induction motor are further classified as

- Squirrel cage rotor,
- Slip ring rotor or wound rotor or phase wound rotor.

STATOR OF THREE PHASE INDUCTION MOTOR

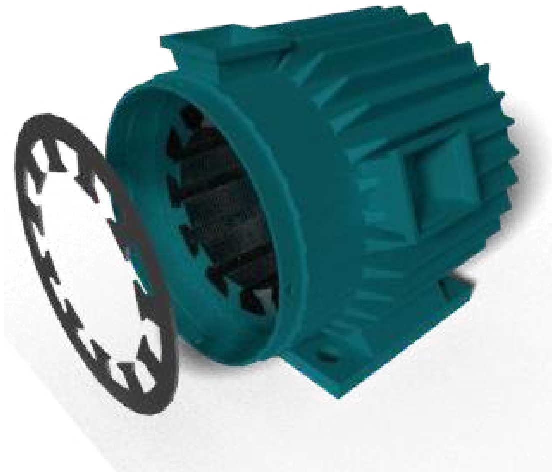
The stator of the three-phase induction motor consists of three main parts :
1. Stator frame,
2. Stator core,
3. Stator winding or field winding.

PARTS OF AC MOTOR (3-PHASE INDUCTION MOTOR)

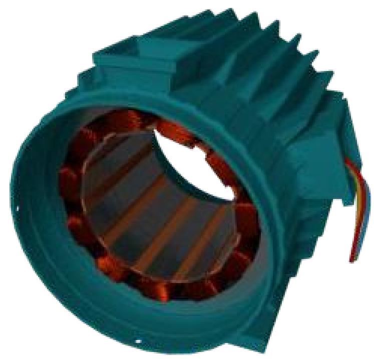


3-Phase Induction Motor

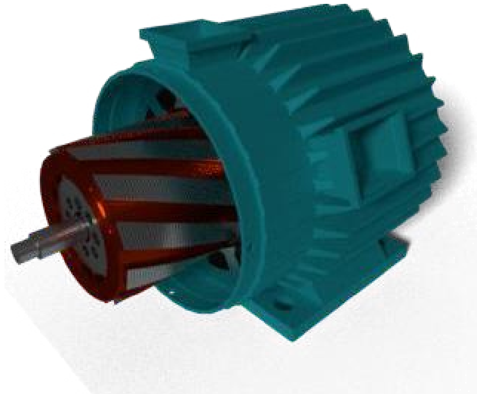
STATOR FRAME



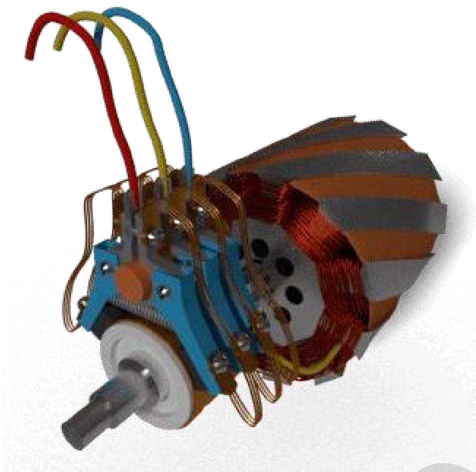
STATOR CORE



STATOR WINDING OR FIELD WINDING



SQUIRREL CAGE THREE PHASE INDUCTION MOTOR



SLIP RING OR WOUND ROTOR THREE PHASE INDUCTION MOTOR