Basics of Electrical & Electronics Engineering

Lab Manual

1st Semester

B.Voc Robotics & Automation

&

B.Voc Tool & Die Manufacturing

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Experiment 1

AIM: Introduction of Tools, Symbols & Abbreviations.

TOOLS:

1. **PLIER**: Generally three types of pliers are used in the electrical workshop. They are:-

- **FLAT NOSE PLIER**: Used for holding jobs or holding wires. It has got only two slotted jaws, which are tapered. Thus it is used for tightening or loosening small nuts.

- **SIDE CUTTING PLIER**: Used for cutting of thin wires and removing insulations from them. It has got cutting edge on its one of its sides.

- **ROUND NOSE PLIER**: Used only to hold or cut the wires. It has no

gripping jaws. Its cutting edge is long and rounded on the top.

2. **SCREWDRIVER**: It is used to loosen or tighten or to keep screws in position. It has a wooden or plastic handle and a blade of high carbon steel.

3. **HAMMER**: Most commonly used in the workshop. The head is made of cast iron or forged; the claw is hardened and tampered. The striking place is slightly convex. The head is fitted with a wooden handle of various lengths.

4. **HACKSAW**: Used to cut metal such as iron strips, core pipes etc. it has a blade made of high steel or tungsten.

Electrical Tools:

1. Test Pen: Test pen is like a small screw driver, having a hollow top of PVC cover with a resistance connected in series with a neon lamp for testing the indication of voltage in any live electric line up to 250V only.

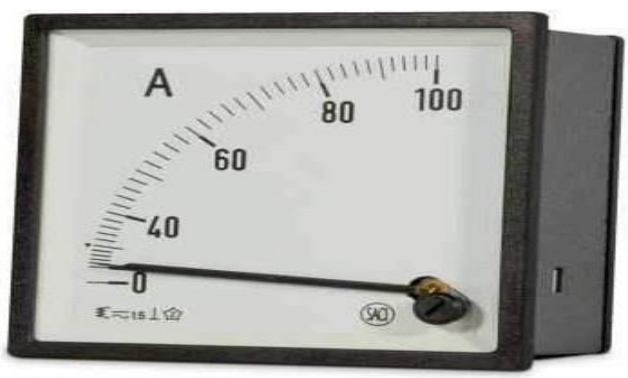
2. Soldering Iron: Soldering iron is an electric device used for soldering the joints with its iron tip. The flux and soldering wire is applied by hot tip to make the joints. It is available in power rating from 150 watt to 250 watt.

3. Drilling Machine: Drilling machine is used for drilling the holes in wooden, battens, board, walls etc. To fix the wooden gutties screws. It is used to do holes in Bakelite sheet board to fix the switch and plugs.

4. **Wire Stripper:** To remove insulation of wire. We used wire stripper.

5. **Volt Meter:** Volt meter is an instrument which is used to measure the potential difference b/w two points of a electric circuit. It connected parallel in the circuit. The voltage is measure in volt (v).

6. **Ammeter:** Ammeter is an instrument which is used to measured current in an electric circuit connected in series. The current in measure in ampere(A).



7. **Multimeter:** Multimeter is a multipurpose instrument which is used for measurement of voltage, resistance continuity etc., of different A.C. and D.C. circuits. It is simple, compact and portable.

Types of Multimeter:

1. Analog Multimeter
2. Digital Multimeter

3. ABBREVIATIONS:

Ω	Ohm
Φ	Phase
A	Amperes
AC	Alternating Current
A/C	Air Conditioning
AHU	Air Handling Unit
AL	Aluminium

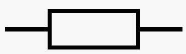
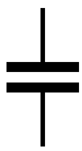
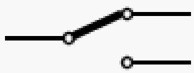
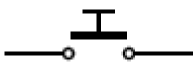
C	Conduit
CB	Circuit Breaker
CCTV	Closed Circuit Television
CIR	Circuit (also: CCT,CKT)
CKT	Circuit (also: CCT,CIR)
CT	Current Transformer
CU	Copper
Db	Decibel
DC	Direct Current
DIA	Diameter
EF	Exhaust Fan
ELEV	Elevator

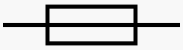
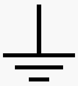
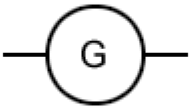
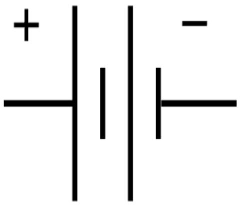
EM	Emergency
F	Fuse
FA	Fire Alarm
GND	Ground
HZ	Hertz
INT	Interlock
KVA	Kilovolt-Amperes
KVAR	Kilovolt-Amperes Reactive
MCB	Main Circuit Breaker
MW	Megawatt
NC	Normally Closed
NO	Normally Open or Number
P	Pole

PB	Push Button or Panic Button
PNL	Panel
PWR	Power
PT	Potential Transformer
QTY	Quantity
REQ	Required
RMS	Root Mean Squared
SP	Spare
SW	Switch
TEL	Telephone
UG	Under Ground
V	Volt
VA	Volt-Ampere

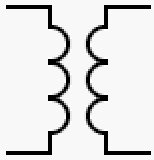
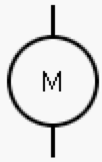
VFD	Variable Frequency Drive
W	Watt
XFMR	Transformer

4. Electrical Symbols :

	Resistor		Resistor
	Inductor / Coil		Capacitor
	Switch		To way switch
	Pushbutton		Plug

	Fuse		Female plug
	Electric line		Plug
	Ground		Female plug
	Electric generator		Battery

=	Direct current, DC	~	Alternating current, AC
+	Positive polarity	−	Negative polarity

	Electric transformer		Electric motor

Experiment - 2

AIM: To Verify KCL & KVL from the given circuit

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	3
3	Ammeter	0-25 mA	3
4	Voltmeter	0-30 V	2
5	RPS	0-30 V	1

THEORY:

Kirchhoff's Voltage Law (KVL) states that the algebraic sum of all branch voltages around any closed path in a circuit is always zero at all instants of time. In the figure 1.1, if KVL is applied then the equation is

$$V_s = V_1+V_2+V_3$$

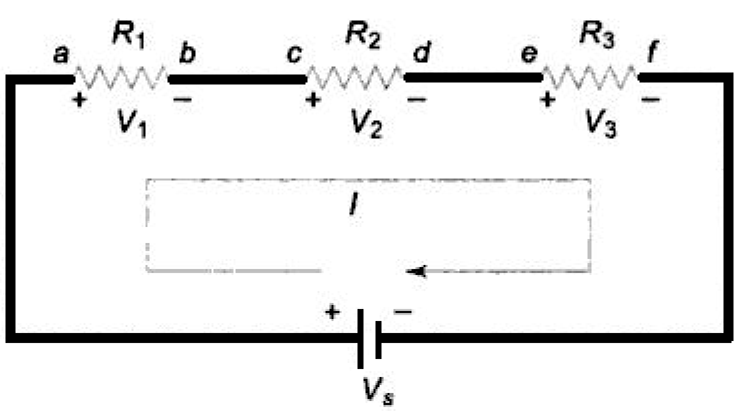


Figure 1.1

Kirchhoff's Current Law (KCL) states that the sum of the currents entering into any node/point/junction is equal to the sum of the currents leaving that node/point/junction. In the figure 1.2, if KCL is applied then the equation is

$$I_T = I_1 + I_2 + I_3$$

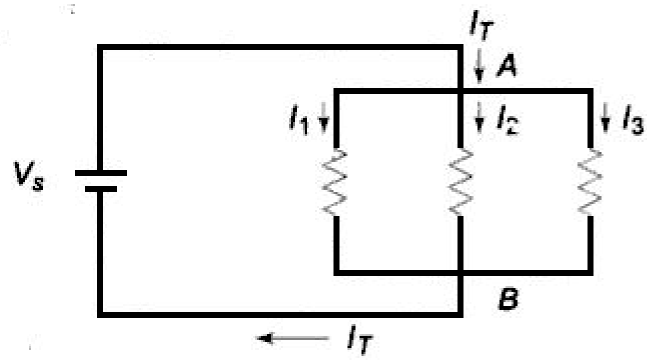


Figure 1.2

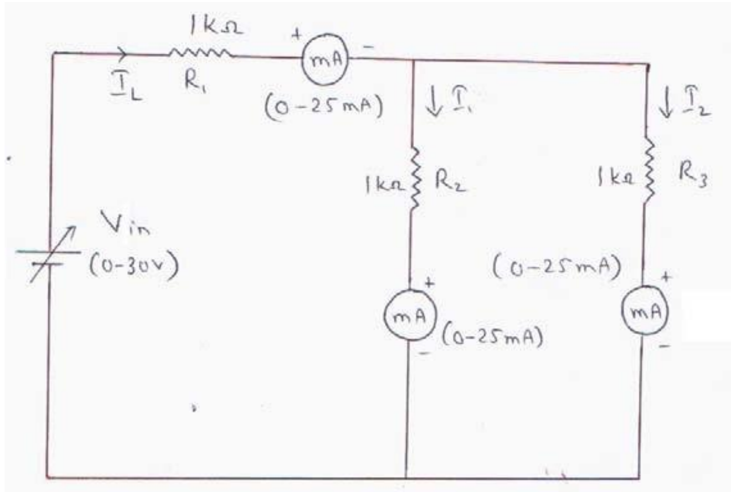
PROCEDURE:

a. Verification of KCL

1. Give the connection according to circuit shown in figure 1.3
2. Vary the supply voltage and take the corresponding readings of I_L, I_1 & I_2 from the ammeter.
3. Verify the reading.

b. Verification of KVL

1. Connection are made as per the circuit diagram shown in figure 1.4
2. Vary the supply voltage and take the corresponding readings V_1 & V_2 from the voltmeter.
3. Verify the reading.



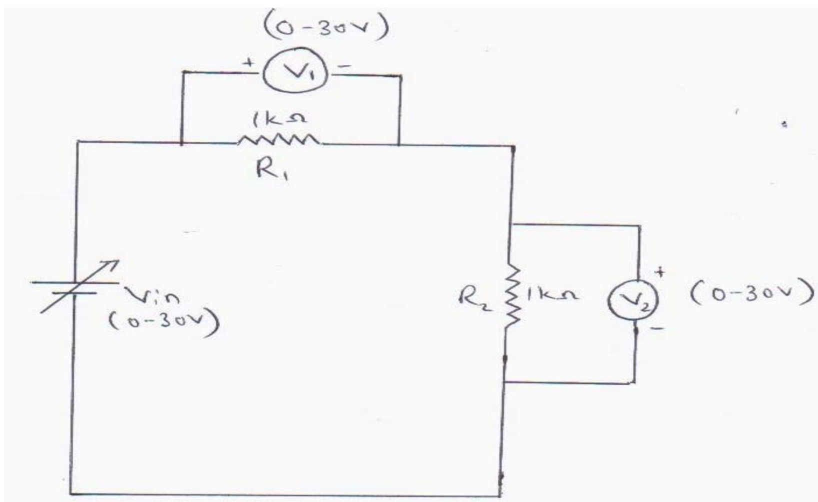


Figure 1.3
Figure 1.4

Tabulation:

Table 1(for KCL):

Vin (v)	I_1 (mA)		I_2 (mA)		$I_L = I_1 + I_2$ (mA)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

Table 2 (for KVL):

Vin (v)	V_1 (v)		V_2 (v)		$V_{in} = V_1 + V_2$ (v)	
	Theoretical	Practical	Theoretical	Practical	Theoretical	Practical

RESULT:

Experiment – 3

AIM: Construction & Working of Direct on line (DOL) starter.

APPARATUS REQUIRED:

S.N0.	Name	Qty.
1.	Three phase induction motor	1
2.	Three phase electro-magnetic contactor	1
3.	Bi-metallic over load relay	1
4.	Push button with NO/NC element	2
5.	M.C.B 3pole	1
6.	M.C.B 1pole	1
7.	Wires	As per requirement

THEORY:

The most simple and inexpensive method of starting a squirrel cage induction motor is the DOL starting method. As the name implies, it switches the motor directly onto the three phase supply.

It is an easiest method for starting up three phase induction motor in which stator windings of the motor are connected directly to the main supply.

When an induction motor is connected to the three phase supply, a very large current typically 5 to 8 times the full load current flows through the motor.
This heavy current reduces as the motor accelerates to its rated speed.

If induction motor is connected directly to the supply, the starting current will not damage the motor unless It is started and stopped repeatedly over a short span of time.

If large rating induction motors are connected directly to the supply, a heavy starting current can damage the motor and also cause disturbance of voltage, i.e., voltage dip on mains supply. This can lead malfunctioning of other equipment connected to the same supply.

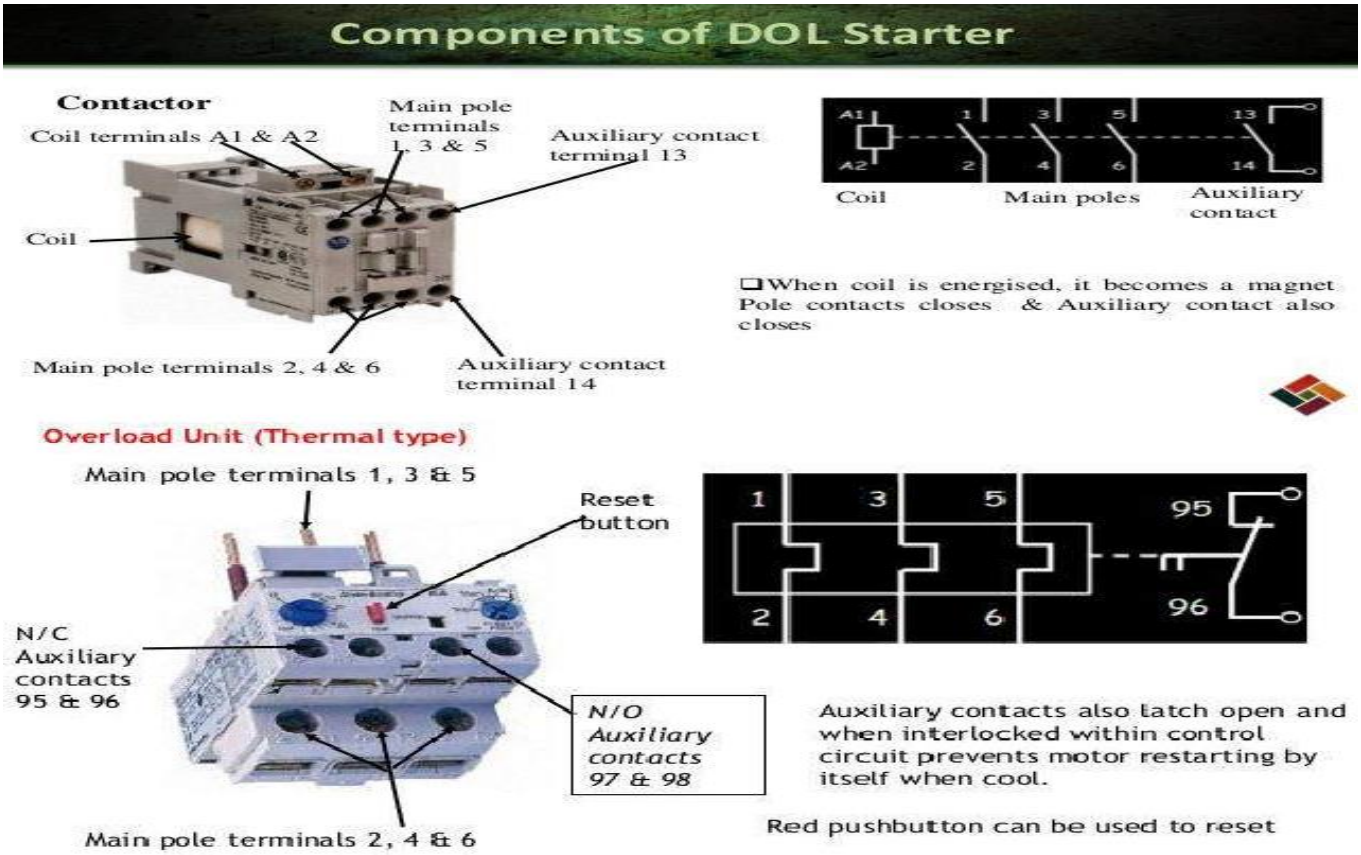
Construction or Parts of DOL Starter

It consists of two push buttons, one is a green button for starting the motor and the other is red for stopping the motor. The switching of power supply is carried through an electromagnetic contactor which can be 3or4 pole contactor.

This electromagnetic contactor has three NO contacts that connect the motor to the supply line while fourth contact (also called as an auxiliary contact) works as hold-on contact when the start button is released in order to energize the contactor coil.

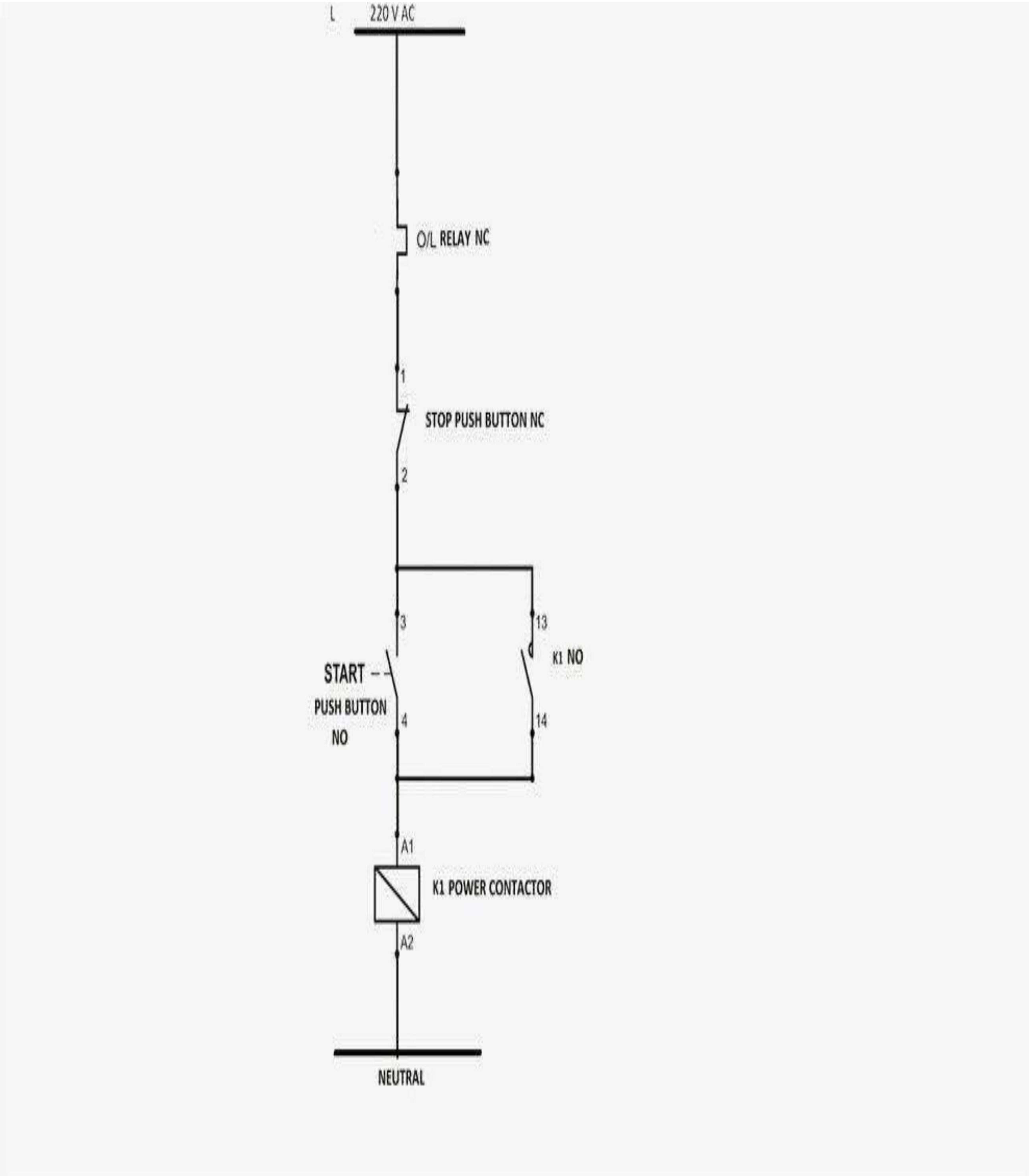
This auxiliary contact (NO or NC) makes the contactor to be electrically latched while motor is operating and these contacts are less power rated than three main NO contacts.

If any reason, power supply fails or voltage drops excessively, it releases the latch by de-energizing the coil and thus motor disconnected from the supply.

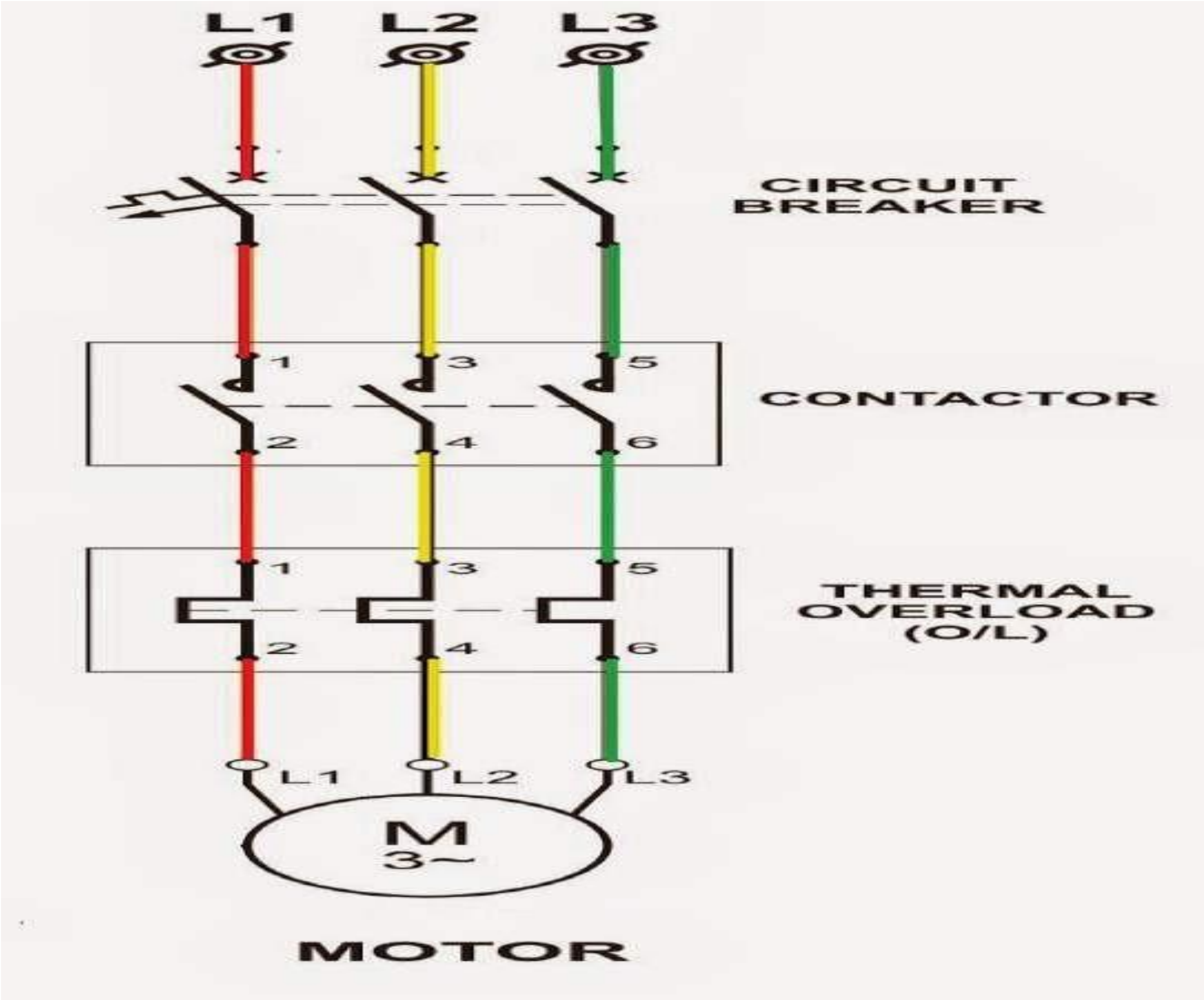


Wiring Diagram: Control

Circuit



Power Circuit:



Procedure:

a. Connect the circuits as shown in the diagram.

b. Switch on the MCB.

c. Use the start and stop pushbuttons for motor operation.

d. Measure the current, voltage, power and the no load speed of the motor.

Result:

1. Current = ……………………A 2.

Voltage =… V

3. Power =…………………..

Experiment-4

AIM: Construction & Working of Star-Delta Starter.

APPARATUS REQUIRED:

Sr. NO.	Name	Qty.
1.	Three phase induction motor	1
2.	3 PoleM.C.B	1
3.	2 PoleM.C.B	1
4.	Three phase electro-magnetic contactor	3
5.	Over load relay	1
6.	Push button with NO/NC element	2
7.	Auxiliary blockNO/NC	4

THEORY:

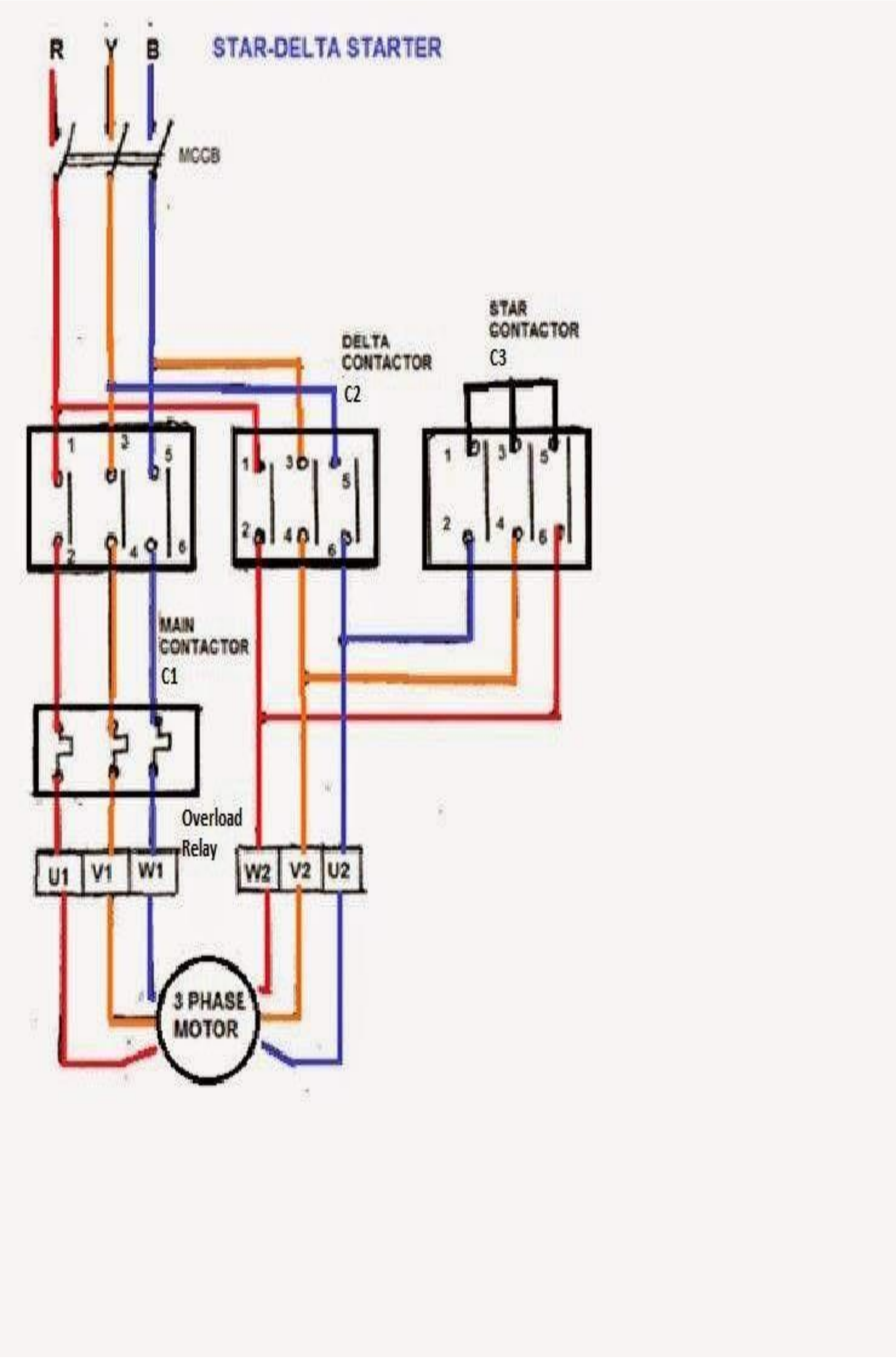
The Star Delta starting method is a motor starting mechanism that minimizes thelarge amountofstartingcurrentthatmotorsdrawinat the time of starting.

It requires three contactors i.e., the Star Contactor, the Delta Contactor and the Main Contactor. However for the motorto be started in Star Delta,its internal connection atthe terminal box has to bewired in Delta-giving it capabilityof receiving the full-loadcurrentatany instant.

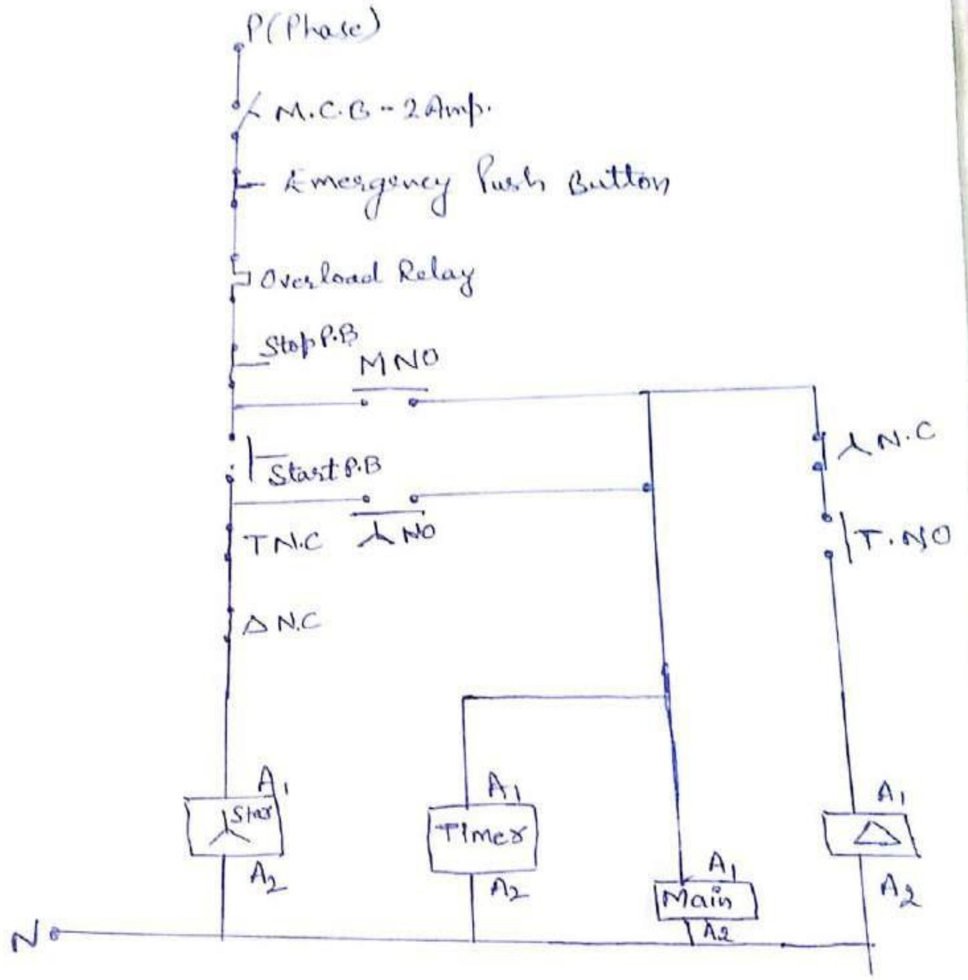
When the power is fed into the circuit,Main Contactor allows currentto flow to the motor. Current flows into the motor and out to the Star which is the star- connected starter. After a specified period defined by the ON delay timer (usually 5 sec) the Delta Closes and star opens to allow the motor to receive the full load current and run at delta. The star and delta contactors are electrically interlocked by using contactors control contacts. if one of them is closed the other cannot close..

WIRING DIAGRAM:

POWERCIRCUIT:



CONTROL CIRCUIT:



Procedure

a. Connect the circuits as shown in the diagram.

b. Switch on the M.C.B.

c. Use the start and stop push buttons for motor operation.

d. Measure the current firstly in star then in delta connections.

Results

Current in star =……………………..A

Current in delta= ……………………..A

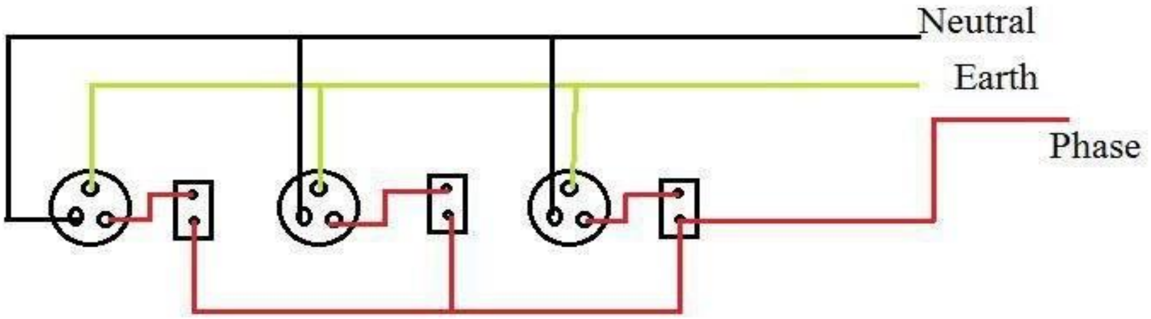
Experiment-5

AIM: Construction & Working of Distribution Board & Extension Board.

APPARATUSREQUIRED:

Sr. No.	Name	Qty.
1.	Socket 5 amp	3
2.	Switch 5 amp	3
3.	P.V.C Wire	As per requirement
4.	P.V.C Board	1

Theory: Extension board is a combination of electrical sockets that attaches to the end of a flexible cable (typically with a mains plug on the other end), allowing multiple electrical devices to be powered from a single electrical socket. Extension board are often used when many electrical devices are in proximity, for ex audio, video, computer systems, Power strips often include a fuse to interrupt the electric current in case of an overload or a short circuit. 0



Extension board Diagram

Procedure:

1. Connect the wires as shown in diagram.
2. Connect the one terminal of each switch with phase wire.
3. Connect the 2nd terminal of switches to the terminal of each sockets.
4. Connect the other terminal of sockets to neutral wire.

5. Connect the other terminal to earth wire.

Precautions:

1. Always connect fuse and switches in phase wire.
2. To avoid leakage current make the earth connection.
3. Make sure no naked wire is without insulations.

Experiment-6

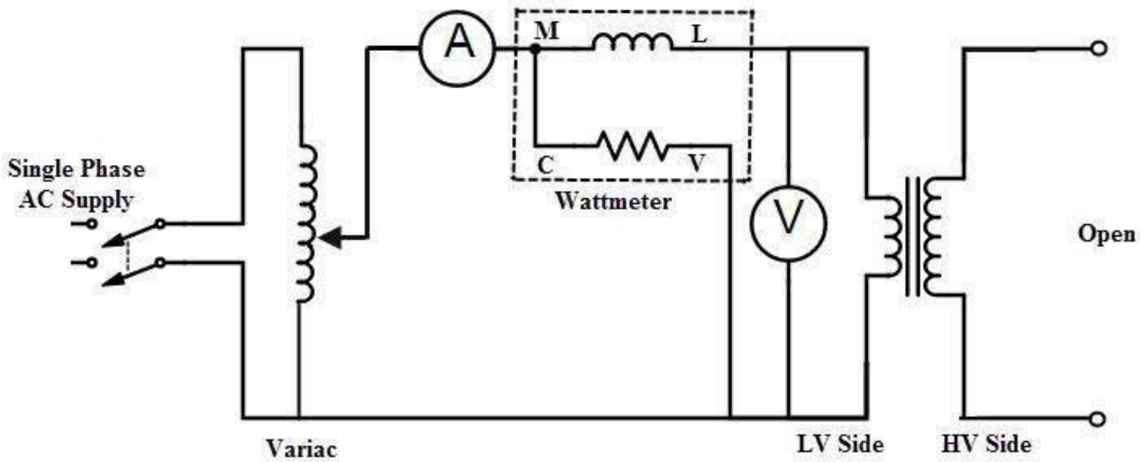
AIM: To perform open circuit test and short circuit test of a single phase transformer.

Open Circuit Test

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 250 W)
2. A.C Voltmeter - 1 nos. (0-250 V)
3. A.C ammeter - 1 nos. (0-2.5 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz)
6. Connecting wire

THEORY: Open circuit test or no load test on a transformer is performed to determine 'no load loss (core loss)' and 'no load current Io'. The **circuit diagram for open circuit test** is shown in the figure below.



Usually high voltage (HV) winding is kept open and the low voltage (LV) winding is connected to its normal supply. A wattmeter (W), ammeter (A) and voltmeter (V) are connected to the LV winding as shown in the figure. Now, applied voltage is slowly increased from zero to normal rated value of the LV side with the help of a variac. When the applied voltage reaches to the rated value of the LV winding, readings from all the three instruments are taken.

The ammeter reading gives the no load current I0. As I0 itself is very

small, the voltage drops due to this current can be neglected.
The input power is indicated by the wattmeter (W). But, as the other side of transformer is open circuited, there is no output power. Hence, this input power only consists of core losses and copper losses. But as described above, short circuit current is so small that these copper losses can be neglected. Hence, now the input power is almost equal to the core losses. Thus, the wattmeter reading gives the core losses of the transformer.

Sr.NO	Voltmeter Reading(V)	Ammeter Reading(A)	Wattmeter Reading

Calculatons:

Calculate the multiplying factor (M.F) of the wattermeter.

M.F= ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin) Iron loss = W (in

Watts) = Wattmeter Reading*M.F

Noloadcurrent=Ammeterreading=I0 Supply

Voltage =Voltmeter Reading = V1

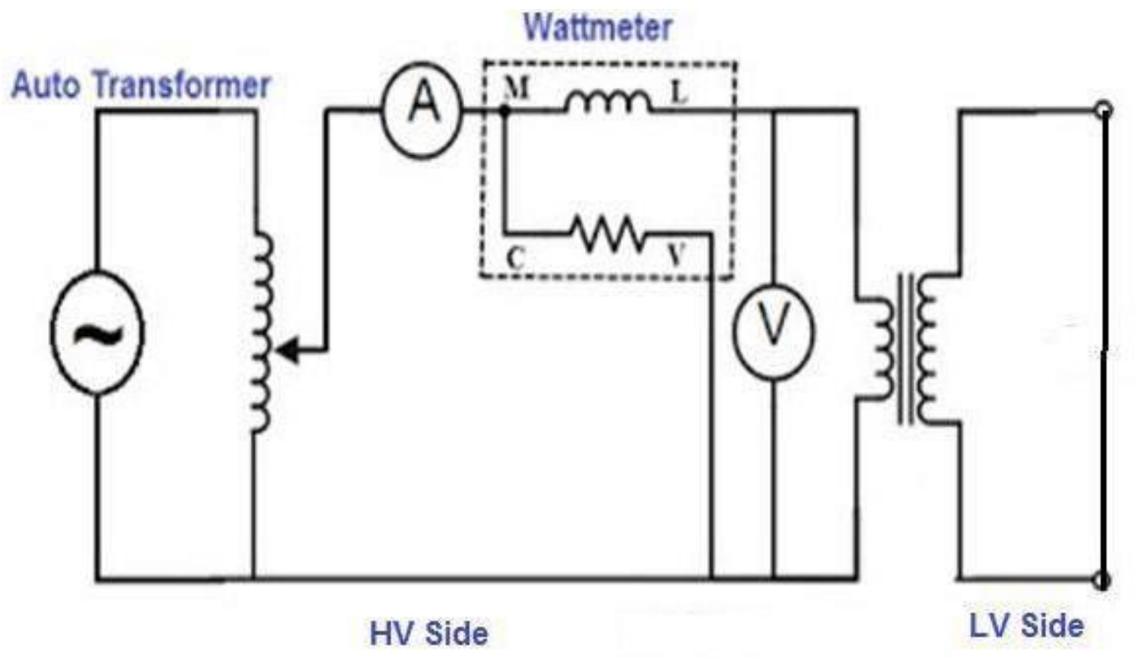
Short Circuit Test

Apparatus Required:

1. A.C Wattmeter - 1 nos. (0- 75 W)
2. A.C Voltmeter - 1 nos. (0-300 V)
3. A.C ammeter - 1 nos. (0-25 A)
4. Variac: 230 V, 10 A, 50 Hz, 1-Phase
5. Transformer (1phase, 50 Hz) 6. Connecting wire

THEORY: The purpose of a **short-circuit test** is to determine the series branch parametersof theequivalentcircuitofarealtransformer.Thetestis conducted on the high-voltage (HV) side of the transformer where the low- voltage (LV) side or the secondary is short circuited. A wattmeter is connected to the primary. An ammeter is connected in series with the primary winding.

A voltmeter is optional since the applied voltage is the same as the voltmeter reading. The LV side of the transformer is short circuited. Now with the help of variac applied voltage is slowly increased until the ammeter gives reading equal to the rated current of the HV side. After reaching at rated current of HV side, all three instruments reading (Voltmeter, Ammeter and Watt-meter readings) are recorded. The ammeter reading gives the primary equivalent of full load current IL. As the voltage applied for full load current in short circuit test on transformer is quite small compared to the rated primary voltage of the transformer, the iron losses in transformer can be taken as negligible here.



Tabulation:

Sl.No. Voltmeter Reading (V) Ammeter Reading (A) Wattmeter Reading

Sr.NO	**Voltmeter Reading(V)**	**Ammeter Reading(A)**	**Wattmeter Reading**

Calculation:

Calculate the multiplying factor (M.F) of the watt meter.

M.F = ((Rating of C.C)*(Rating of P.C)*cosϕ)/(Wattmeter Ratingin) Copperloss=

Wsc(inWatts)=WattmeterReading*M.F

Short circuit current=Ammeter reading= Isc Voltmeter

Reading = Vsc

Copper loss = Wattmeter Reading =Wsc Calculate the values of R01, X01, Z01.

Precautions:

1. All the connections should be tight and clean.

2. Special care should be taken while selecting the ranges of the meters for conducting short-circuittest

3. Special care should be taken while selecting the ranges of the meters for conducting open-circuittest.

4. While conducting the short-circuit test, the voltage applied should be initially set at zero, and then increase slowly. If a little higher voltage than the required voltage be applied (by mistake), there is a danger of transformer beingdamaged.

Experiment-7

Aim: Construction & Working of Half Wave & Full Wave rectifier on bread board.

APPARATUS REQUIRED:

S.NO.	Name of the Apparatus	Range	Quantity
1	Bread Board	-	1
2	Resistor	1 KΩ	1
3	Transformer	6-0-6	1
4	Diode	1N4007	1
5	CRO	-	1
6	Multimeter	-	1
7	Function Generator	-	1

THEORY:

Rectifier changes ac to dc and it is an essential part of a power supply. The unique property of a diode, permitting the current to flow in one direction, is utilized in rectifiers.

HALF WAVE RECTIFIER: Mains power supply is applied at the primary of the step down transformer. All the positive half cycles of the stepped down ac supply pass through the diode and all the negative half cycles get eliminated. Peak value of the output voltage is less than the peak value of the input voltage by 0.6 V because of the voltage drop across the diode.

For a half wave rectifier, $V_{rms} = V_m/2$ and $V_{dc} = V_m/\pi$ where V_{rms} = rms value of the input, V_{dc} = Average value of input and V_m = peak value of the output. The ripple factor $r = V_{r,rms}/ V_{dc}$ where $V_{r,rms}$ is the rms value of the accomponent.

$r = \{(V_{rms}/ V_{dc})^2 – 1\}^{1/2}= 1.21$

FULL WAVE RECTIFIER: During the positive half cycle of the transformer secondary voltage, diode D_1 is forward biased and D_2 is reversed biased. So a current flows through the diode D_1, load resistor R_L and upper half of the transformer winding. During the negative half cycle, diode D_2 becomes forward biased and D_1 becomes reverse biased. The current then flows through the diode D_2, load resistor R_L and lower half of the transformer winding. Current flows through the load resistor in the same direction during both the half cycles. Peak value of the output voltage is less than the peak value of the input voltage by 0.6 V because of the voltage drop across the diode.

For a full wave rectifier, $V_{rms} = V_m/1.414$, $V_{dc} = 2V_m/\pi$.

Ripple factor $r = \{(V_{rms}/V_{dc})^2 - 1\}^{1/2} = 0.48$

PROCEDURE:

1. The circuit of half wave rectifier is made as shown in figure 8.1 in bread board.
2. Switch on mains supply. Observe the transformer secondary voltage waveform and output voltage waveform across the load resistor, simultaneously on the CRO screen. Note down V_m & calculate V_{rms} & V_{dc}
3. Calculate the ripple factor using the expression and plot the waveform.
4. Repeat the above steps for full wave rectifier where the circuit of full wave rectifier is shown in figure 8.2.

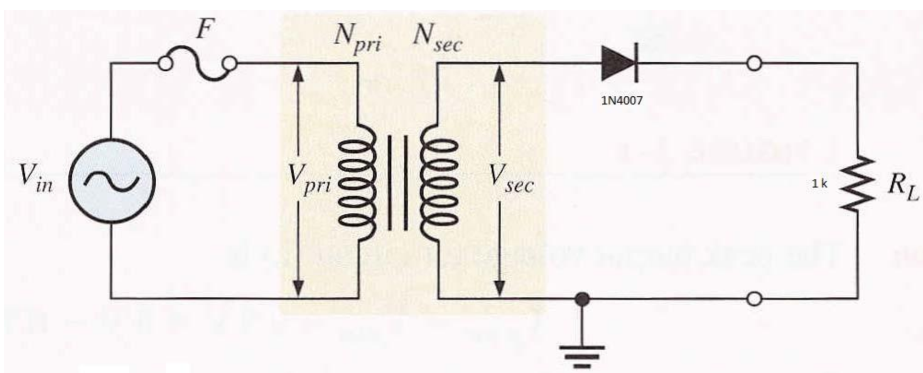


Figure 8.1

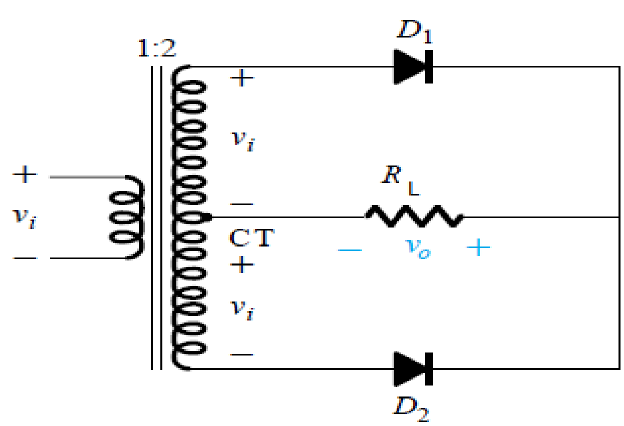
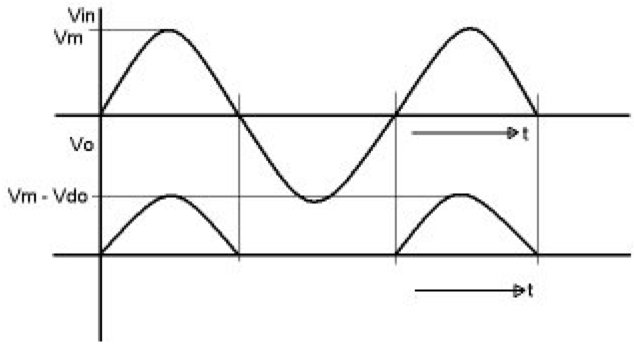


Figure 8.2

Model Graph:

Half Wave Rectifier: V_{do} stands for voltage drop across the diode.



Full Wave Rectifier: