GENERAL RULES FOR BEEE LAB

- All students in the lab are expected to stick to the following guidelines:
- The students are supposed to come in proper lab uniform dress. Wearing shoes in the electrical lab is compulsory.
- Take your lab work seriously and behave appropriately in the laboratory. Be aware of your classmates' safety as well as your own at all times.
- To successfully complete the experiments in one lab period, you must come prepared to the laboratory. You must read the experiment in advance and answer the pre-lab questions.
- Return the components to the correct bins when you are finished with them.
- Before leaving the lab, place the stools under the lab bench.
- Before leaving the lab, turn off the main power switch to the lab bench.
- Keep your work area neat and in order- Have only books and other materials that are needed to conduct the experiment in the laboratory.
- Experiment: The student works with a partner and they both take the data on separate lab observation. The Staff in-charge/lab instructor will look at the data and sign on your observation note book at the end of the experiment.
- This laboratory can be used by students during laboratory hours only.

SAFETY PRECAUTIONS

- Always observe the following safety precautions when working in the laboratory:
- Do not work alone while working with high voltages or on energizing electrical equipment's.
- Power must be switched off whenever an experiment or project is being assembled/disassembled/modified. Remember that capacitors can store dangerous quantities of energy.
- Do not allow any part of your body to contact any part of the circuit or equipment connected to the supply.
- Only use the tools with insulated handle.
- Wearing a ring or watch can be hazardous in an electrical lab since such items make good electrodes for the human body.
- When using rotating machinery like fan, etc, place neckties or chains inside your shirt or better remove them.
- Never use water on an electrical fire, only use CO_2 or dry type fire extinguishers.
- Never handle wet or ungrounded electrical equipment's. Do not touch switch boards, main switches, holder points, etc with wet hands.
- Do not use a plier as a hammer. Do not put a sharp edged tool in your pocket.
- Know the location and how to operate shut-off switches and/or circuit breaker panels. Use these devices to shut off equipment in the event of a fire or electrocution.
- Never disconnect a plug point by pulling the flexible wire.

List of experiments

Sl.No	Date	Name of experiments(electrical)	Remarks	Staff sign
1		Study of tools and accessories		
2		Study of Electrical Accessories and Symbols		
3		STAIR-CASE wiring		
4		Doctor’s room wiring		
5		Bed room wiring		
6		Godown wiring		
7		Fan and tube light		

Sl.No	Date	Name of experiments(electronics)	Remarks	Staff sign
1		Study of CRO		
2		Verification of Kirchhoff laws		
3		Characteristics of PN junction diode		
4		Study of rectifiers		
5		Study of logic gates a)verification of truth table of logic gates		
		b)Verification of de Morgan’s theorem		
		c) Implementation of digital functions using logic gates and universal gates		

ELECTRICAL

CABLE SELECTION FOR TYPICAL DOMESTIC LOADS

Sl. No.	Items	Load / Wattage	Fuse / MCB rating	Wire size (in Sq.mm)
1	Fan	60W	---	1
2	Lamp / Tube Light	40W	---	1
3	Room Heater	200W	1A	1.5
4	Water Heater : 8 Lts. 15 Lts. 60 Lts.	 2000W 4000W 6000W	 10A 20A 32A	 2.5 4 6
5	Immersion Heater	1000W	6A	1.5
6	Hot Plate – Single	1000W	6A	1.5
7	Iron (Automatic)	1000W	3A	1.5
8	Mixer / Juicer	300W	2A	1.5
9	TV	200W	1A	1.5
10	Music system	200W	1A	1.5
11	Refrigerator: 165 Lts. 285 Lts. 350 Lts.	 400W 600W 750W	 3A 4A 6A	 1.5 1.5 1.5
12	Toaster	500W	3A	1.5
13	Vacuum Cleaner	400W	3A	1.5
14	Washing machine -without heater -with heater	 1300W 6300W	 10A 32A	 2.5 6
15	Water cooler	700W	6A	1.5
16	Desert cooler	300W	2A	1.5
17	Oven	750W	6A	1.5
18	Electric Kettle	1500W	7.5A	1.5
19	Air conditioner	1 ton 1.5 ton 2 ton	10A 16A 16A	2.5 4 4
20	Hair Dryer	1000W	7.5A	1.5
21	Microwave	800W	6A	1.5

Fuse Calculation:

Fuse current rate calculation for each Load = (watts/volts) X 1.25

(or)

I_{fuse} = (P/V) X125% of current rating

For a lamp of 230 V,60 W,

I_{fuse} = (60/230) X 1.25 =0.32 A ≅1 A

For lamp of 230V,15 W,

I_{fuse} = (15/230) X 1.25 =0.08 A ≅0.5 A

For a Ceiling fan of 230 V,70 W

I_{fuse} = (70/230) X 1.25 =0.38 A ≅1 A

For a fluorescent lamp of 230 V,40 W,

I_{fuse} = (40/230) X 1.25 =0.22 A ≅1 A

1.STUDY OF TOOLS AND ACCESSORIES

Objective:

To have a detailed knowledge about the electrical tools and accessories used for wiring.

Study of Electrical Tools:

Screw driver:

Size: 10, 15, 20, 30 cm

Uses: Used for tightening or loosening or to keep the screws in position. These are available indifferent blades sizes and shapes. The screw driver has two parts, blade and handle generally of steel and plastic respectively. A good screw driver has its edge hardened and temped.

Precautions: Avoid greasy or oily handle. Do not use in place of chisel. Use proper size for particular screws.

Neon Tester:

Rating: 500V

Uses: Neon tester has a narrow body containing a light that is connected to two wires with short metal probes at their ends, protected by two insulated grips. It is used in checking the glow of current in the circuit or lines. It resembles as just like that of a screw driver.

Precautions: Do not drop it. Do not use it as screw driver if not specified.

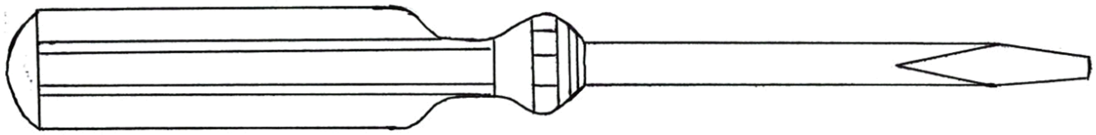
Insulated Combination Pliers:

Size: 15, 20, 25 cm

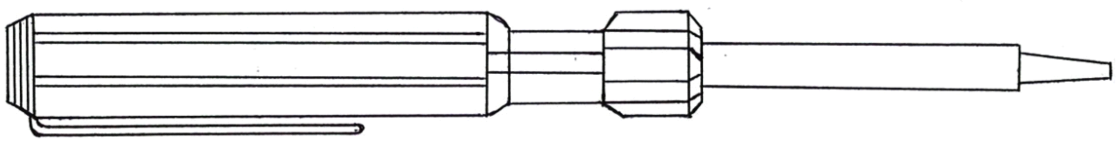
Uses: Used for cutting, gripping, twisting and holding the articles, wires, etc. There is a provision of doing number of operations by a single plier, so it is known as the combinational pliers.

Precautions: Do not cut steel wires. Do not hold any hot substance. Do not use in place of hammer.

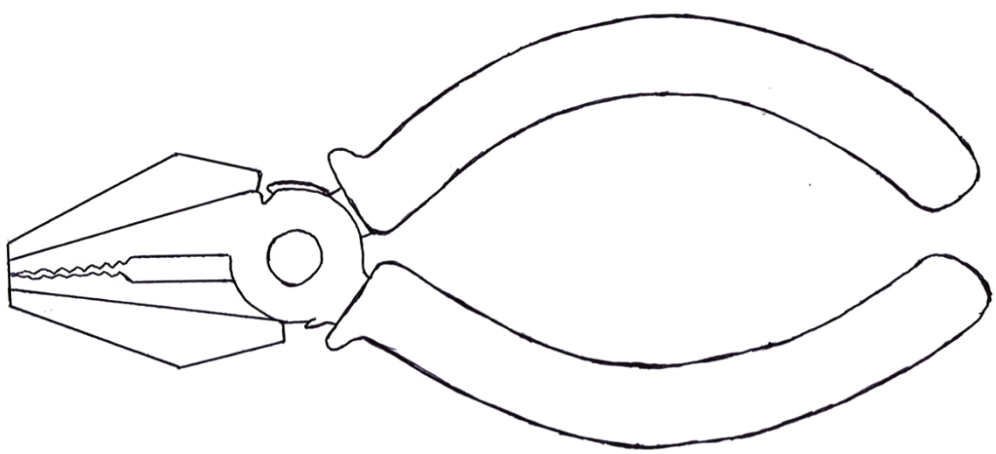
SCREW DRIVER



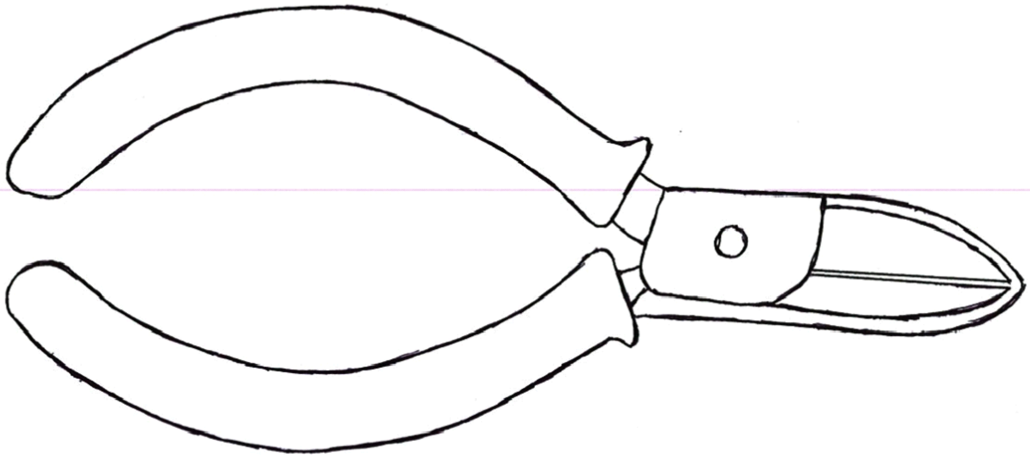
NEON TESTER



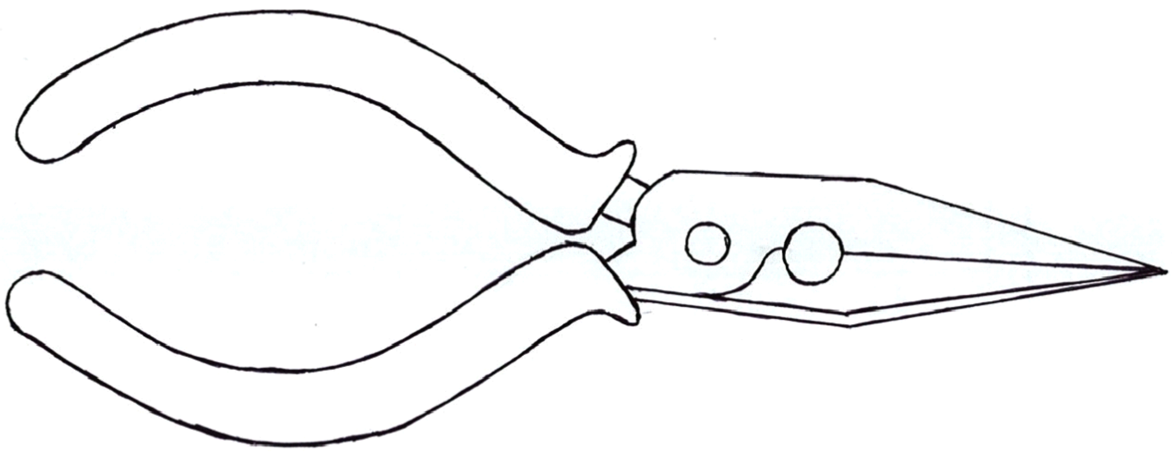
Insulated Combination Pliers



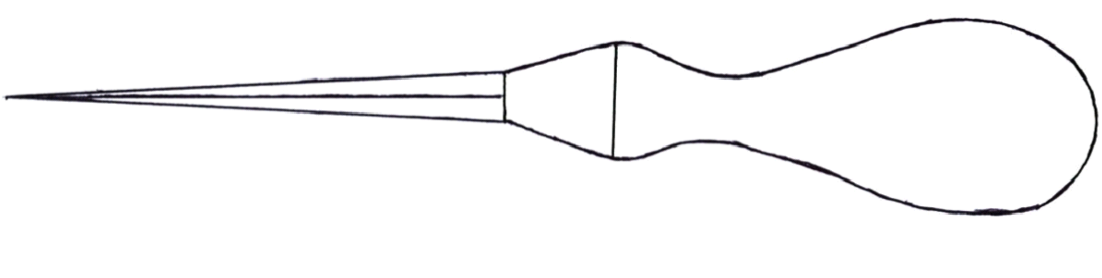
SIDE CUTTER



LONG NOSE PILER



POKER



Side Cutter:

Size: 20 cm

Uses: For cutting wire at narrow places or ordinary places. For removing insulation of the cable.

Precautions: Do not cut steel substance. Protect from rust. Do not cut hot substance.

Long nose plier:

Size: 10 cm

Uses: For holding, twisting or joining the wires at narrow places.

Precautions: Do not cut steel substance. Protect from rust.

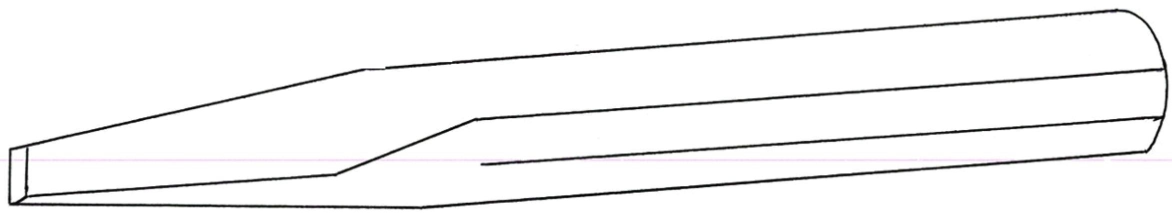
Poker:

Size: 10, 15 cm

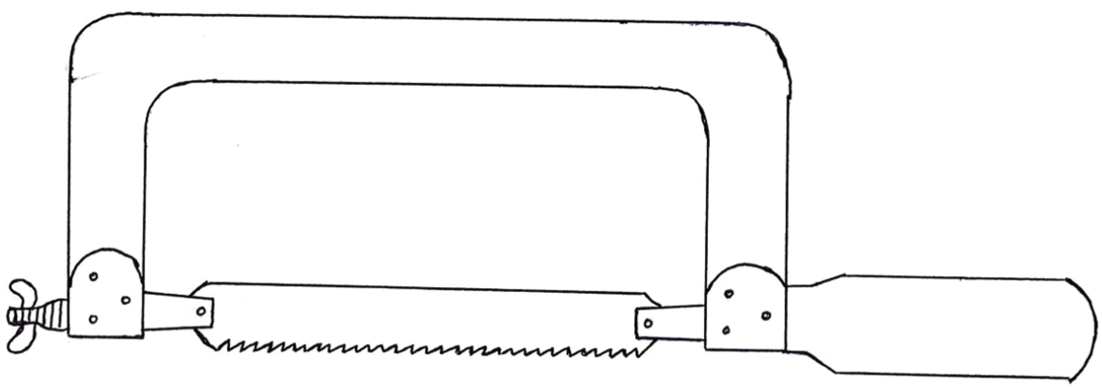
Uses: Used for making pilot holes for fixing screws on wooden board.

Precautions: Do not use it on the metals.

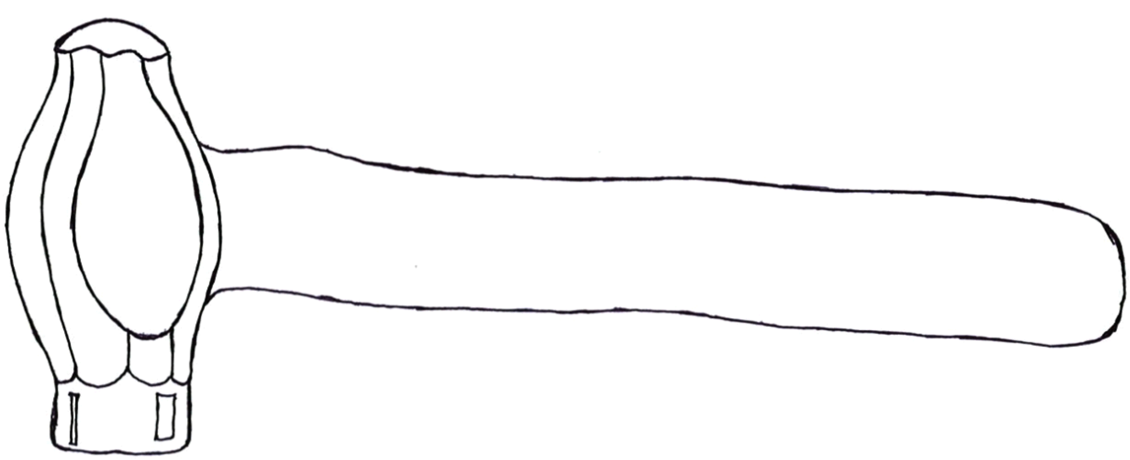
Cold chisel



Hack saw



BALL PEEN HAMMER



Cold chisel:

Size: 10, 15 cm

Uses: Used for chapping, boring and chambering in walls.

Precautions: Should not be oily. Avoid flat head.

Hack saw:

Size: 16, 20, 25, 30 cm

Uses: Used for cutting conduit G.I. pipes or mild steel.

Precautions: Keep straight while cutting. Keep safe from rust during cutting; apply water on blade while cutting.

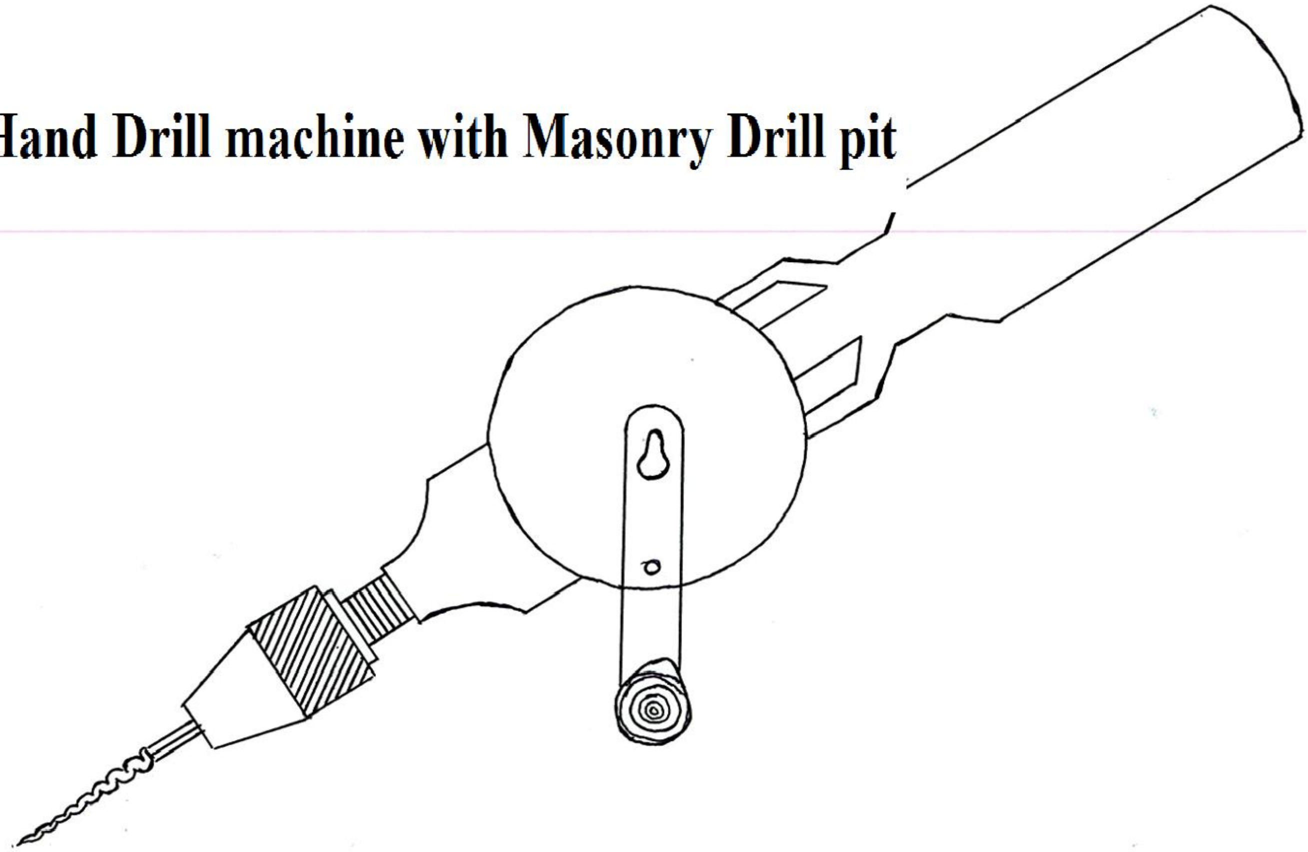
Ball peen hammer:

Weight: ¼ kg to 2 kg

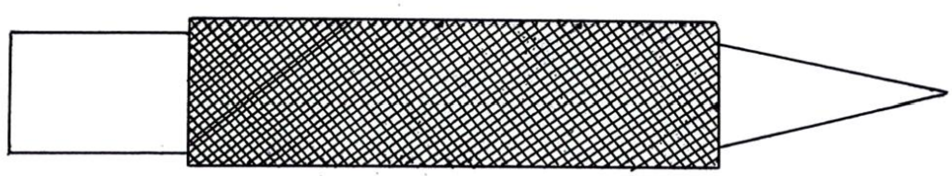
Uses: Best suited for chipping on teak wood batten and riveting purpose in sheet metal works.

Precautions: Never use loose handles hammer. Hammer handle should not be greasy.

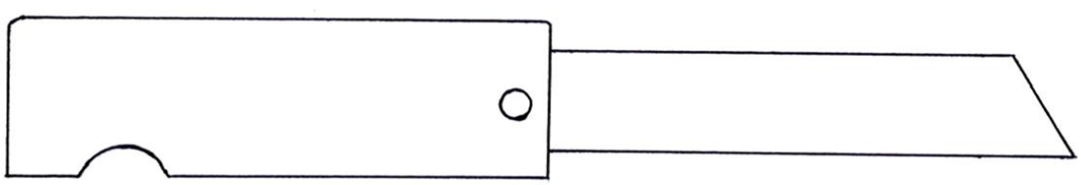
Hand Drill machine with Masonry Drill pit



Center punch



Electrician Knife



Hand Drill machine with Masonry Drill pit:

Size: 3mm, 6mm, 12mm

Uses: Used for making holes in wooden blocks, boards and plastic plugs.

Precautions: Should be kept clean and without greasy handle. Should be used straight.

Center punch:

Size: 100mm, 150mm

Uses: Used for making guide holes for drilling in metals.

Precautions: Should not be used on high speed steel.

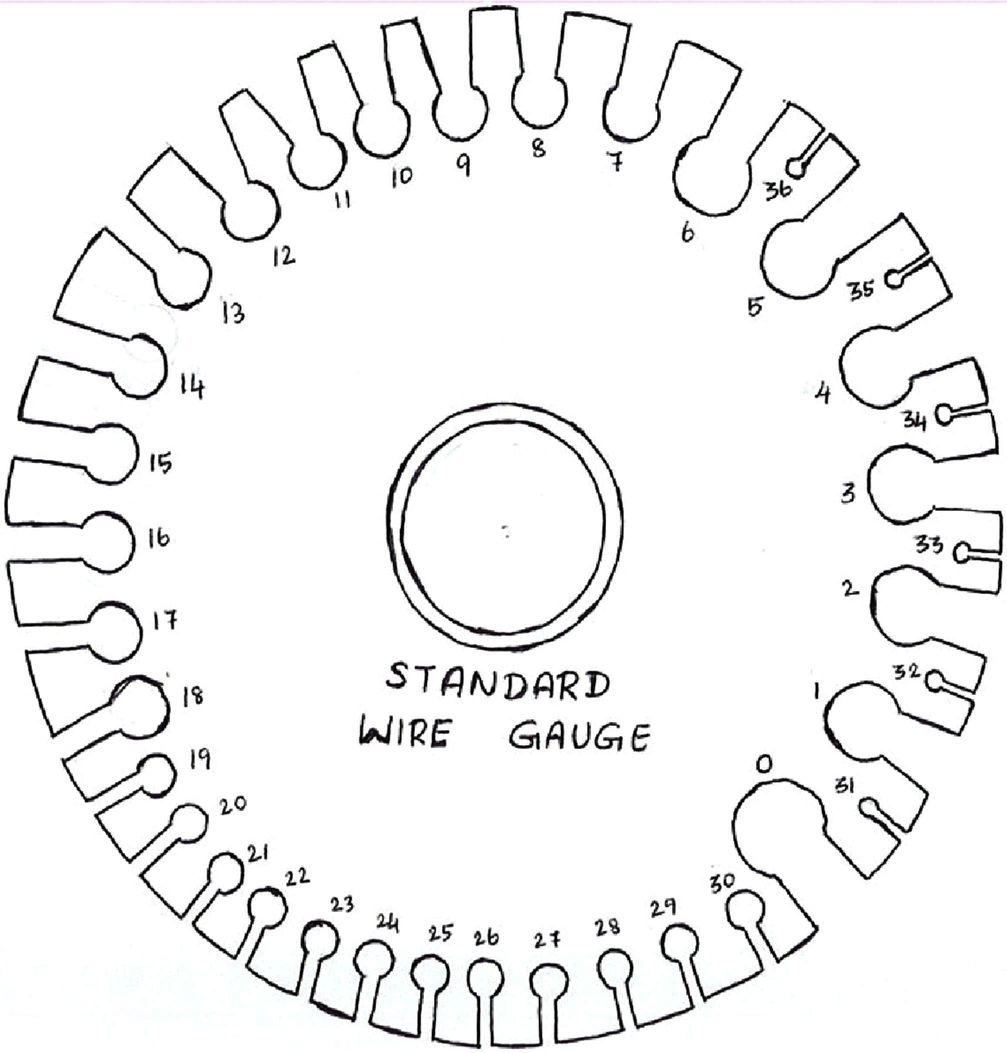
Electrician Knife:

Size: 10cm

Uses: It has two blades, one for removing insulation of wires and other for cleaning the wires.

Precautions: protect from rust. Do not use it for cutting wires.

Standard wire gauge



Standard wire gauge:

Use: Used for measuring the gauge of wire. It is made up of thin plate having a number of slots with makings on its circumference. While measuring, the conductor should be freely inserted in the slot.

Procedure: Remove the insulation for about 4cm. Place the bare conductor in the slot of wire gauge. Keep testing the wire in various slots until it fits easily in one of them. Read the gauge number of the slot on the face of the wire gauge in which bare conductor fix easily. This is the required gauge number of wire.

Precautions: Cut the insulation like mending a pencil so that there should not be any cut in the conductor. The bare conductor should not be loose or tight enough in the slot. Measure the wire many times at different place then take mean.

2)STUDY OF ELECTRICAL ACCESSORIES

Fuse:

It is made up of a Porcelain or Bakelite. It has only two terminals which can be seen from the back of the switch as shown in fig. If any short circuit or overload in any line of an AC or DC circuit, the fuse will suddenly blowout, so that the electrical equipment's or instruments will be protected. Generally, fuses are available in 230V, 5A/16A/32A, etc.

Single way switch:

This type of switch is used in an electrical circuit to control electrical equipment. Only the phase wire is connected in the switch terminal which is made of Bakelite or Porcelain. It has only two terminals which can be seen from the back of the switch. Generally, switches are available in 230V, 5A, 16A rating.

Two way switch:

This type of switch is used in electrical circuit to control a lamp from two different places. It has three terminals which can be seen from the back of the switches as shown in the fig. Generally, these switches are 230V, 5A/16A ratings. Generally there are used in staircase wiring where a single lamp is controlled from two different places.

Bell-push:

This type of switch is used in electrical circuits to control a calling bell. It has two terminals, which can be seen from the back of the switch as shown in the fig. It has two contacts. Generally switches are available in 230V, 5A rating.

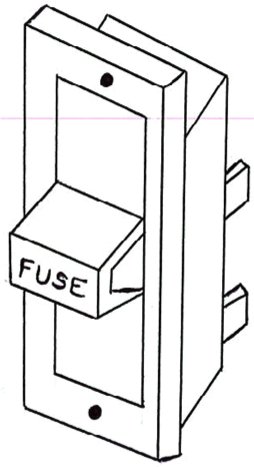
Three pin socket:

These types of socket are used to take supply for the portable equipment's, which is having the body earthing. There are three terminals marked as supply (live) in the right side, neutral on the left side and the earth terminal on the top. Generally sockets are available in 5A/16A/32A ratings

Two-pin socket:

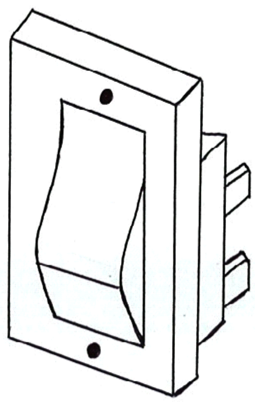
These types of sockets are used to take supply for the portable equipment's. There are two terminals marked as supply (live) on the top, neutral on the bottom and no earth terminal, as shown in fig., Generally sockets are available in 230V, 5A rating.

FUSE



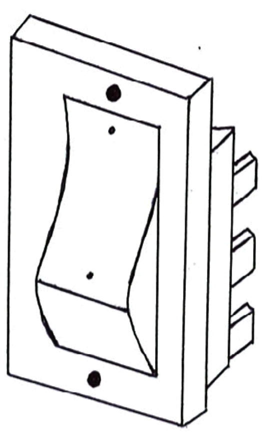
SINGLE POLE SINGLE THROW SWITCH

(OR) ONE WAY SWITCH

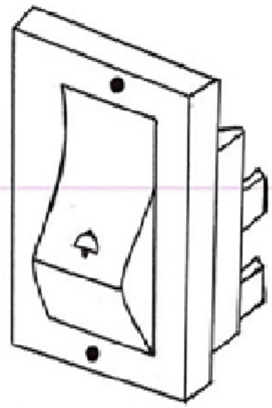


SINGLE POLE DOUBLE THROW SWITCH

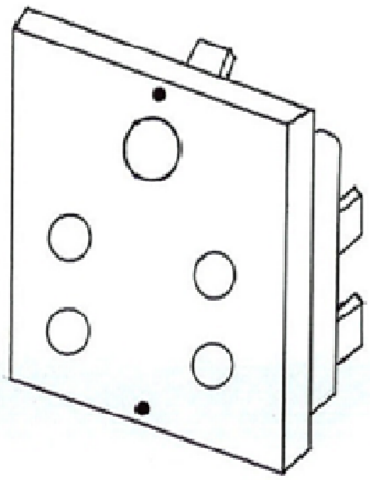
(or) TWO WAY SWITCH



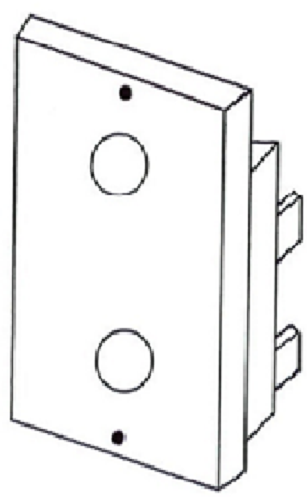
BELL PUSH



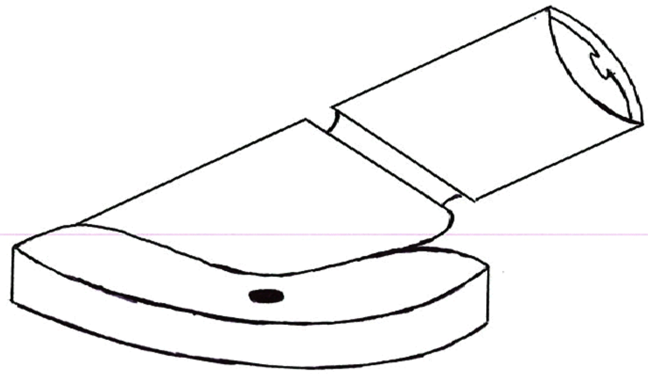
5 PIN SOCKET



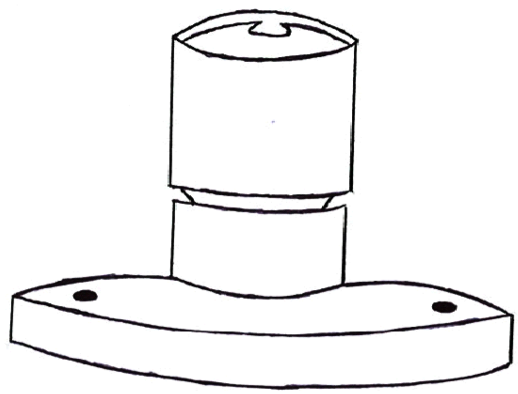
2 PIN SOCKET



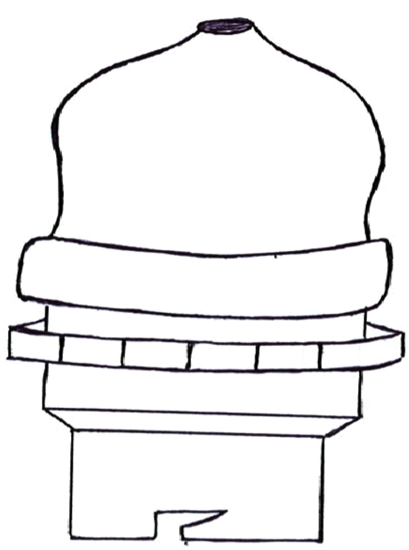
ANGLE HOLDER



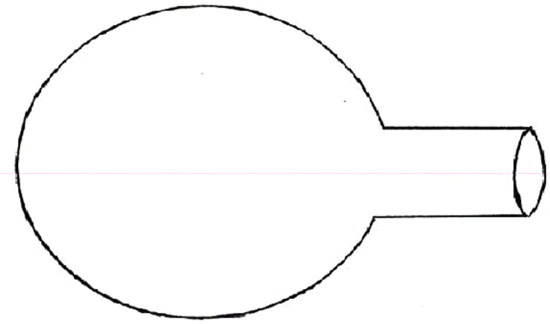
BATTEN HOLDER



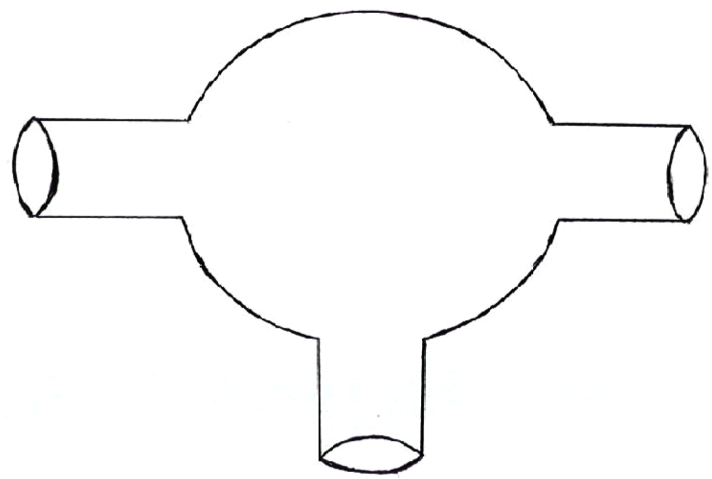
PENDENT HOLDER



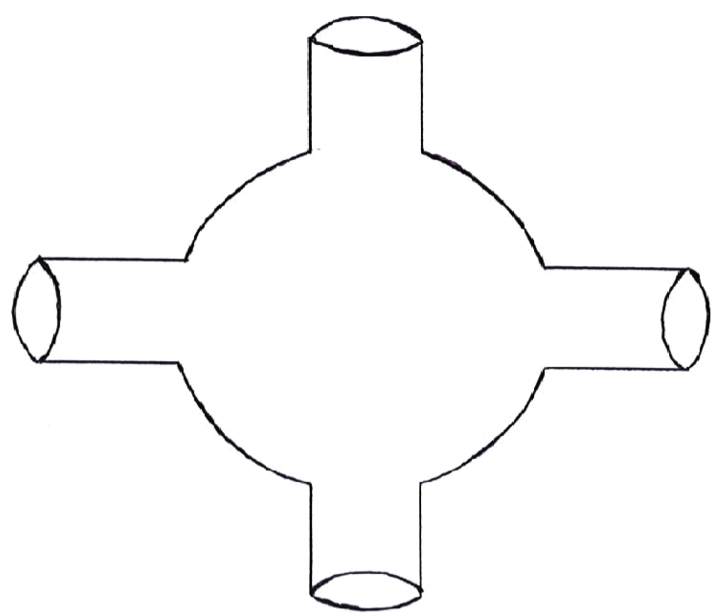
ONE WAY JUNCTION BOX



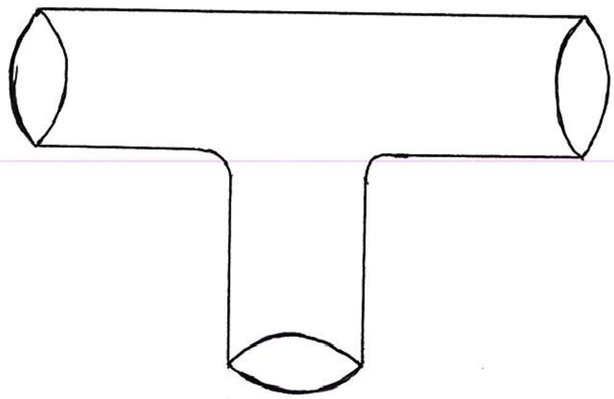
THREE WAY JUNCTION BOX



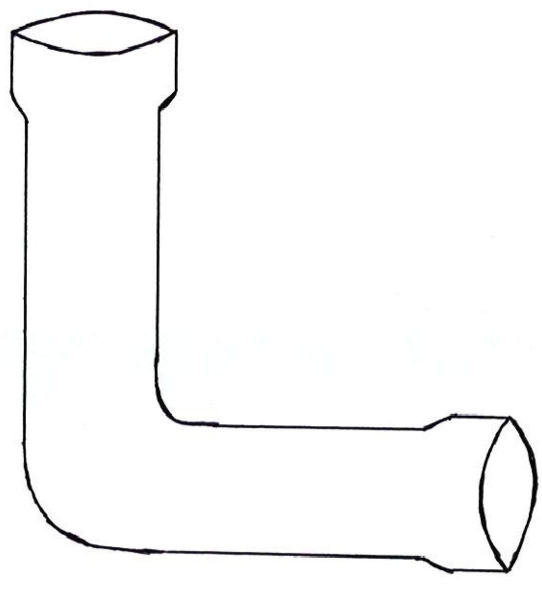
FOUR WAY JUNCTION BOX



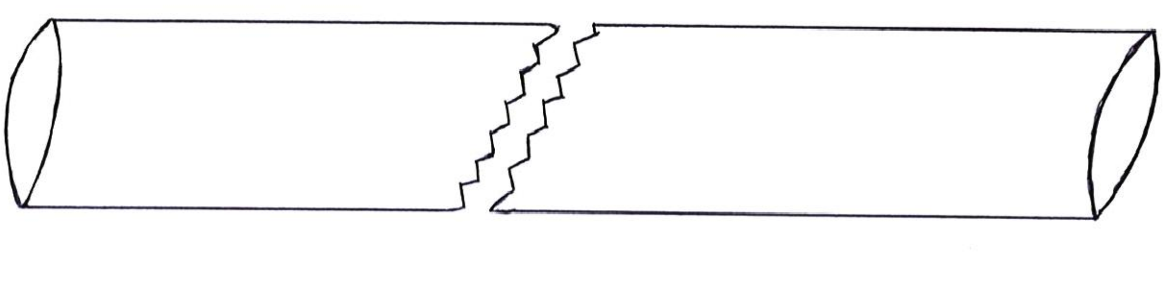
T-BEND



BEND



PVC PIPE



Angle Holder:

These holders are used in the advertising boards, foot lights, kitchen, etc., and as the name explains the lamp is kept at a particular angle as shown in the fig. It has two terminals, one for phase and another for neutral. It is made of porcelain or Bakelite. Generally, sockets are available in 230V, 5A ratings.

Batten Holder:

These holders are used on the flat surface. The connecting pins have springs so that the lamp may be fixed tightly. There are two grooves on the circular construction of that holder as shown in the fig. It has two terminals, one for phase, and the other for neutral. It is made of porcelain or Bakelite. Generally, sockets are available in 230V, 5A ratings.

Pendent Holder:

These holders are used where the lamps are in hanging positions as shown in the fig. It has two terminals, one for phase, and the other for neutral. It is made of porcelain or Bakelite. Generally, sockets are available in 230V, 5A ratings.

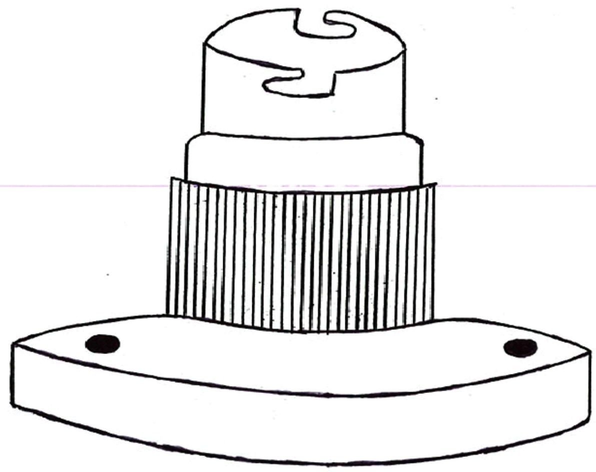
Button Holder:

These holders are used in switchboards. These types of holders are in the same construction of batten holder as shown in the fig., and made of porcelain or Bakelite. It has two terminals, one for phase, and the other for neutral. Generally, sockets are available in 230V, 5A ratings.

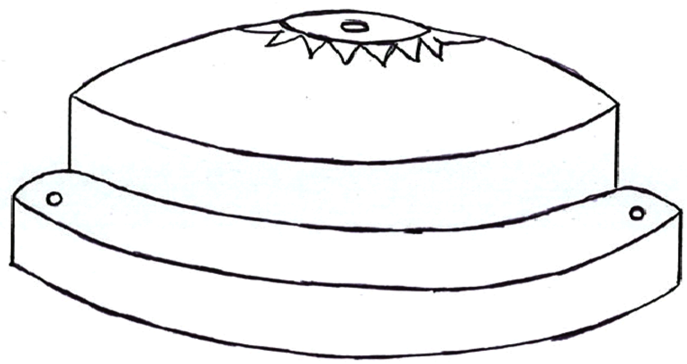
Ceiling Rose:

These are used to take supply for fans, tubes, lamps, etc., from the wall or ceiling. They are having two parts, the base and the cover. The cover has a hole in the center to take out the connecting wires as shown in the fig., It has two terminals, one for phase, and the other for neutral. It is made of porcelain or bakelite. Generally, sockets are available in 230V, 5A ratings.

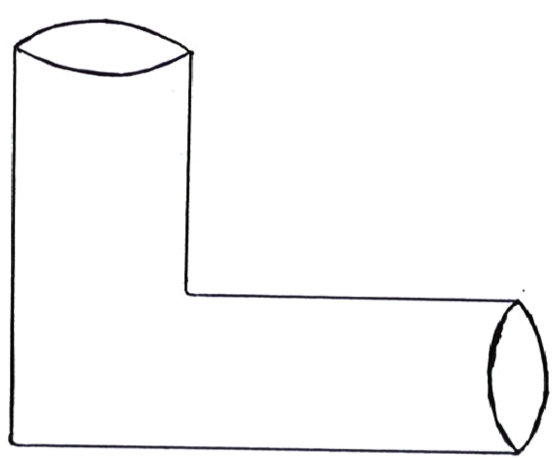
BUTTON HOLDER



CEILING ROSE



ELBOW BEND



Elbow bend:

These elbow bend is used in wiring at wall corner for turning of wire. Generally they are made of PVC.

Junction boxes:

There are different types of junction boxes: They are

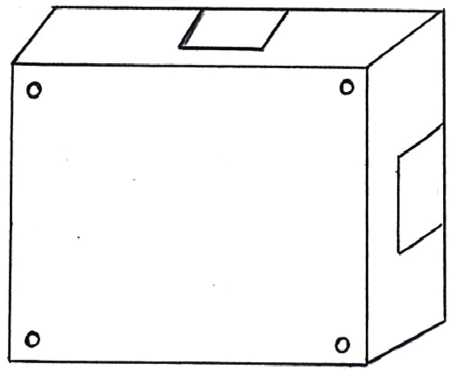
- One way junction box
- Two way junction box
- Three way junction box
- Four way junction box

These are used in house wiring to open a sub-line. They are generally made up of PVC.

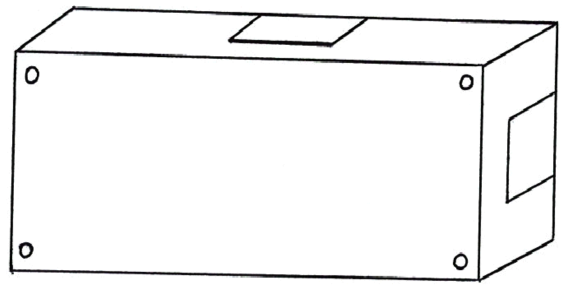
G.I. clamps:

It is made of galvanized iron; its thickness is 3/4. It is used for fixing the PVC pipes.

PVC SWITCH BOX

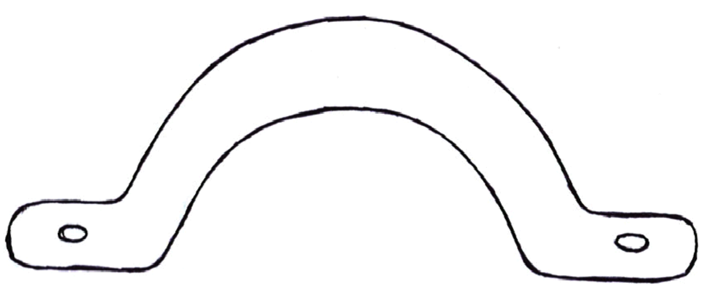


4X4 PVC SWITCH BOX

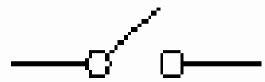
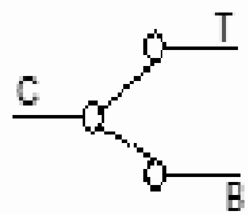
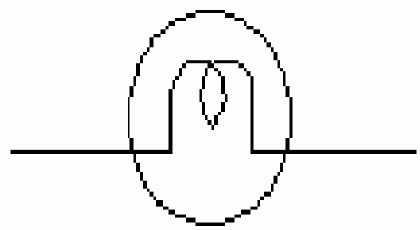
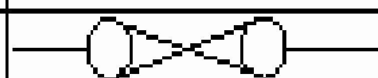
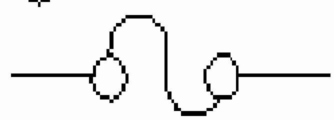
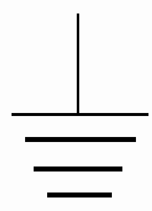
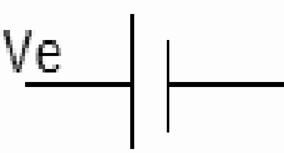


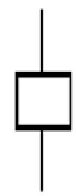
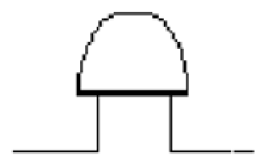
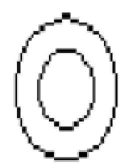
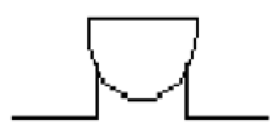
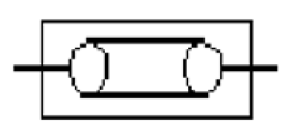
6X4 PVC SWITCH BOX

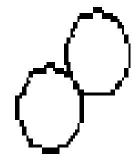
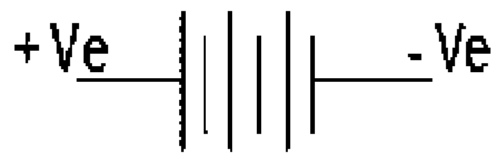
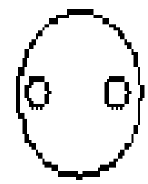
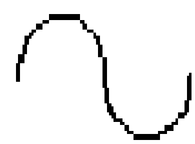
CLAMP

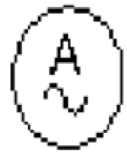
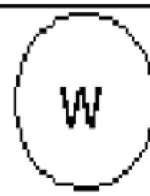
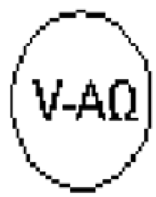
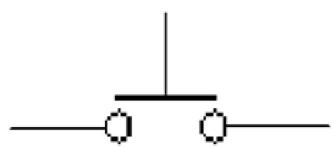
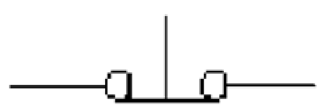


2. STUDY OF SYMBOLS

SL NO:	Name of the symbol	Symbol
1	Single pole single throw switch	
2	Single pole double throw switch	T-TOP C-CENTRE B-BOTTOM 
3	Lamp	
4	Fuse	 OR 
5	Earth	
6	Cell	+ Ve  - Ve

SL NO:	Name of the symbol	Symbol
7	Circuit breaker	
8	Fluorsent lamp	
9	bell	
10	Push (or)Bell button push	
11	Buzzer	
12	NEUTRAL LINK	

SL NO:	Name of the symbol	Symbol
13	Ceiling fan	
14	Battery	
15	Ceiling rose	
15	Alternating current	
16	Direct current	
17	Ac volt meter	

SL NO:	Name of the symbol	Symbol
18	AC/DC volt meter	
19	AC Ammeter	
20	AC/DC Ammeter	
21	Wattmeter	
22	Multimeter	
23	Push switch Normaly open	
24	Push switch Normaly close	

3. STAIR-CASE WIRING

Objective:

To control an incandescent lamp from two different places

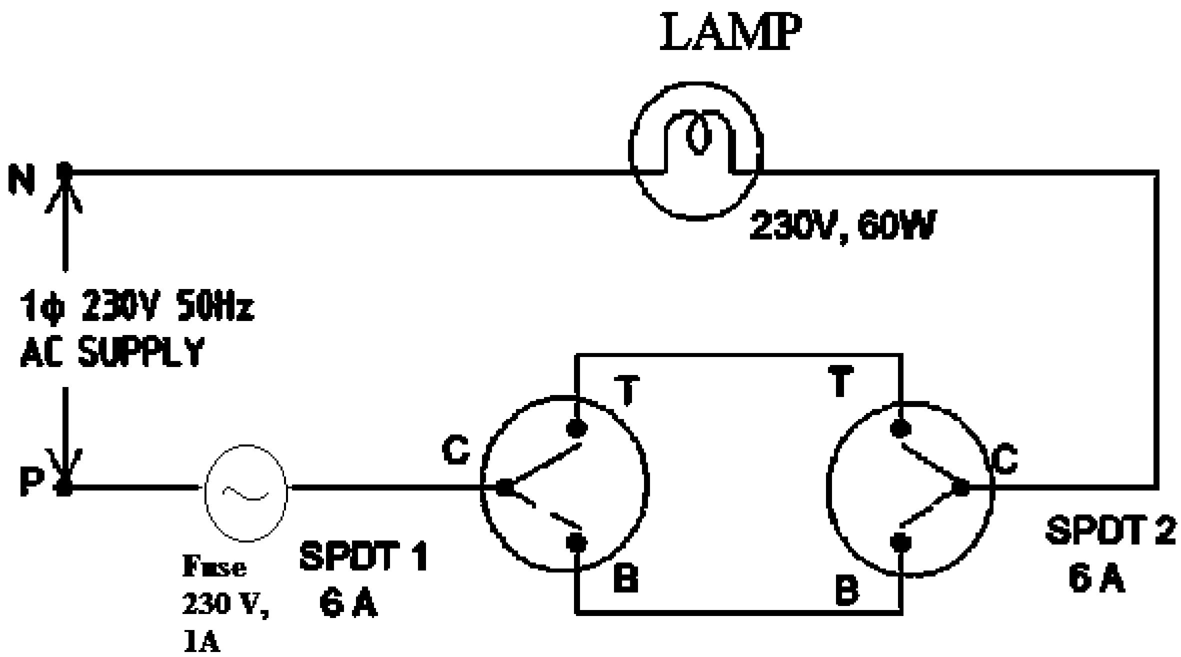
Components required:

Sl. No.	Name of the components	Rating	Quantity
1	One –way junction box	19 mm	1
2	Three – way junction box	19 mm	1
3	Switch box	4 x 4	2
4	PVC pipes	19 mm	4
5	G.I. clamps	(3/4 inch)	4
6	Screws	---	15
7	Fuse	230V, 10A	1
8	Two – way switch	230V, 10A	2
9	Batten holder	230V, 10A	1
10	Incandescent lamp (Bulb)	230V, 60W	1
11	Connecting wires (multi-stand Cu.)	---	---
12	Wooden working board	---	---

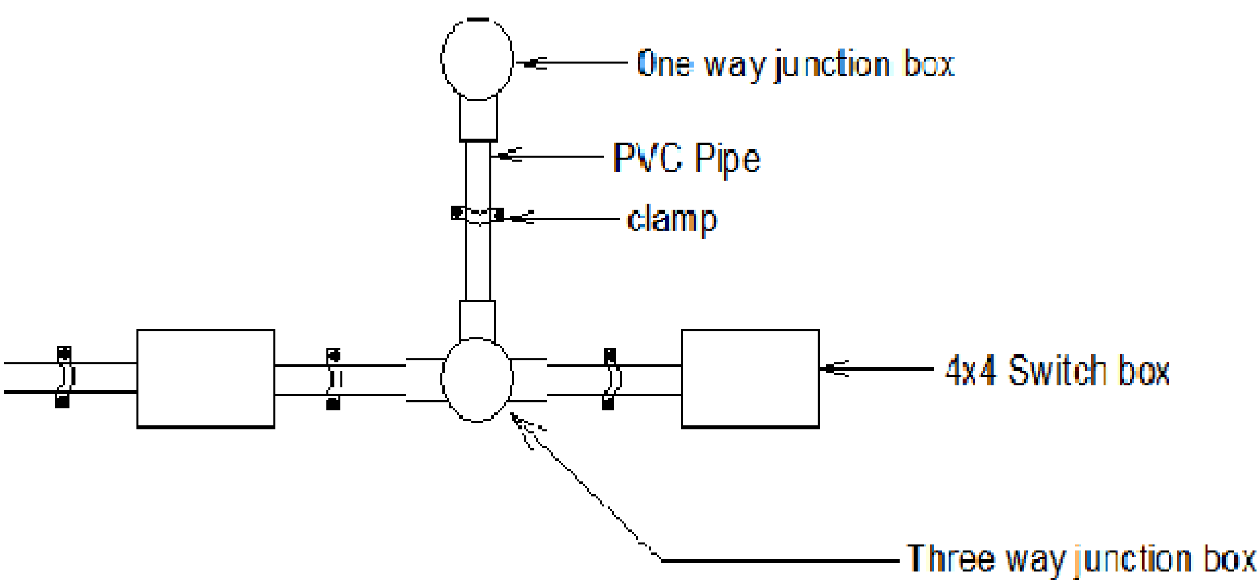
Procedure:

- Initially suitable junction boxes, PVC pipes and switch boxes are selected
- As per the layout diagram (1b) junction boxes, PVC pipes and switch boxes are fixed rigidly on the wooden board with the help of GI clamps.
- As per the circuit diagram (1a) the connections are given:
- The Phase wire is connected to the common terminal of the two-way switch (SPDT-1) through fuse.
- From the other two throw points of SPDT-1, wires are connected to the two throw points of SPDT-2. (ie. top terminals of SPDT-1 and SPDT-2 are connected and bottom terminals of SPDT-1 and SPDT-2 are connected).
- From the common terminal of SPDT-2, wire is taken to any one terminal of the incandescent lamp (bulb).
- The other terminal is taken out as the neutral line.
- Connections are checked using the wiring diagram (1c) and the truth table (1d) is verified for different combinations.
- Now the lamp can be controlled from two places irrespective of the position of the switches.

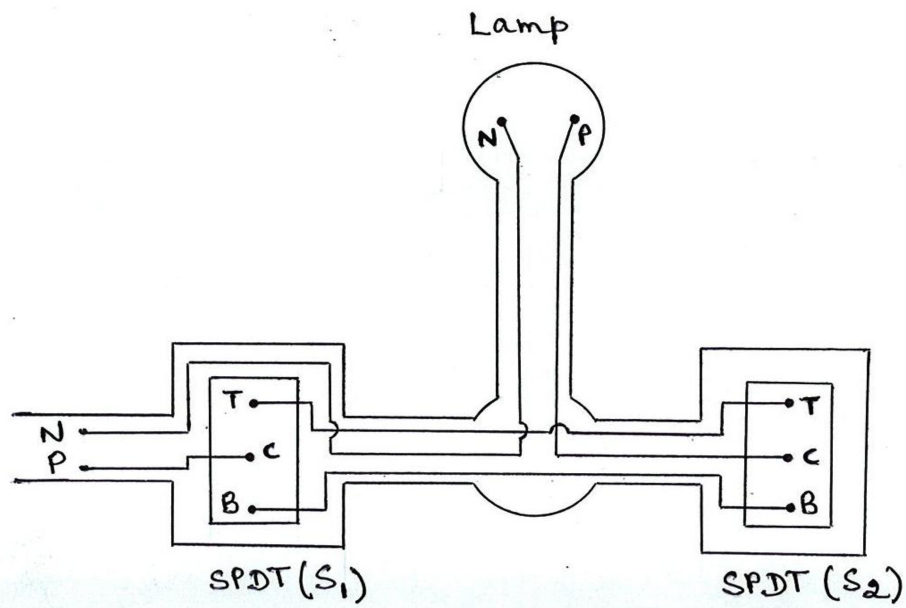
Circuit diagram:



Layout diagram:



Wiring Diagram:



Truth Table:

S_1	S_2	Lamp
T	T	ON
T	B	OFF
B	B	ON
B	T	OFF

Result:

Thus a lamp is controlled from two different places and truth table is verified for all the combinations.

4. DOCTOR'S ROOM WIRING

Objective:

To make a doctor's room wiring

Components required:

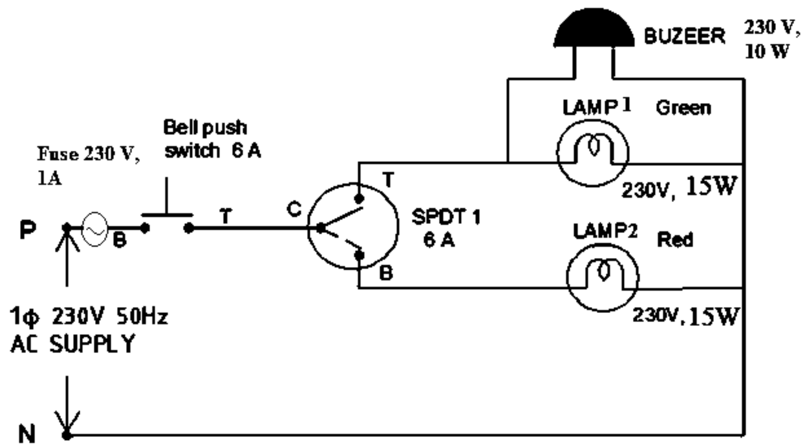
Sl. No.	Name of the components	Rating	Quantity
1	One –way junction box	19 mm	2
2	Three – way junction box	19 mm	1
3	Four - way junction box	19 mm	1
4	Switch box	4 x 4	2
5	PVC pipes	19 mm	6
6	G.I. clamps	(3/4 inch)	6
7	Screws	---	20
8	Fuse	230V, 10A	1
9	Two – way switch	230V, 10A	1
10	Batten holder	230V, 10A	1
11	Bell push	230V, 10A	1
12	Buzzer	230V, 10W	1
13	Ceiling rose	230V, 10A	1
14	Incandescent lamp (Green + Red)	230V, 15W	1 + 1
15	Connecting wires (multi-stand Cu.)	---	---
16	Wooden working board	---	---

Procedure:

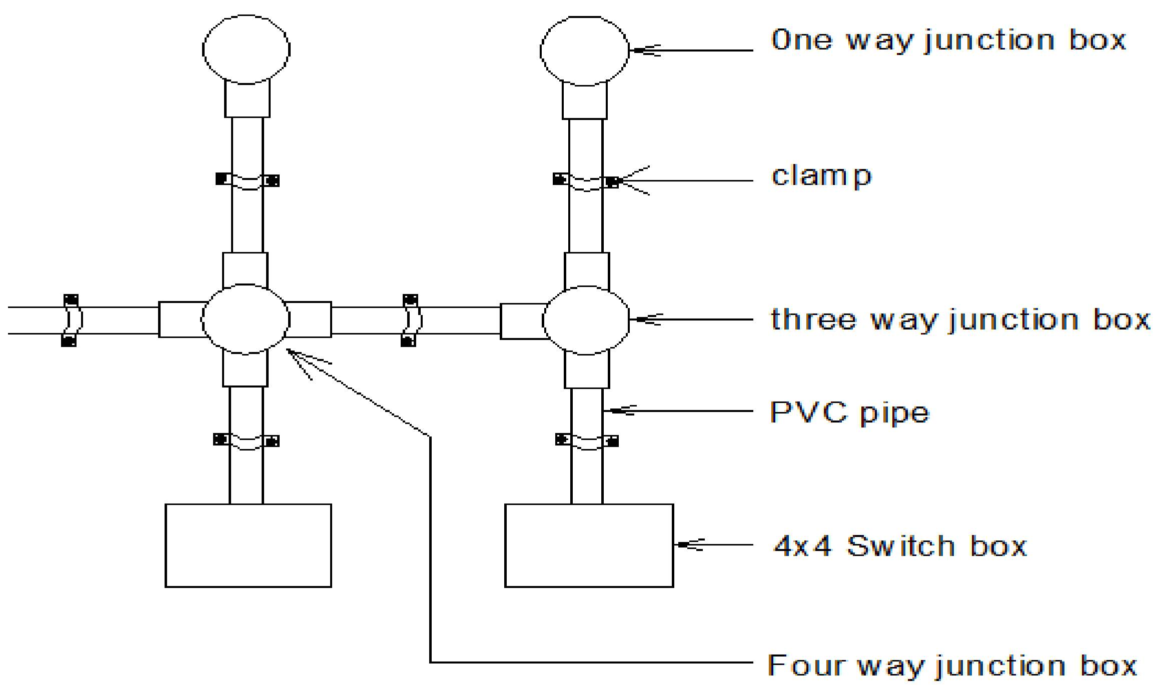
- Initially suitable junction boxes, PVC pipes and switch boxes are selected. Required connecting wires are taken.
- As per the layout diagram (2b) junction boxes, PVC pipes and switch boxes are fixed rigidly on the wooden board with the help of GI clamps.
- As per the circuit diagram (2a) the connections are given:
- The phase wire is connected to the top terminal of the bell push S1 through proper fuse.
- From the bottom terminal of the S1, wire is taken and connected to the common terminal of S2 (SPDT).

- From top terminal of the switch S2, two wires are taken, one wire is connected to one terminal of batten holder (lamp-1) and other wire is connected to one terminal of the ceiling rose (buzzer).
- From the bottom terminal of S2, a wire is taken and connected to one terminal of the batten holder (lamp-2).
- Other terminals from the button holders (L1 – L2) and the ceiling rose (buzzer) are connected together and taken out as neutral wire.
- Connections are checked using the wiring diagram (2c) and the truth table (2d) is verified for different combinations.
- Now the lamps (Lamp in and Lamp out) and the buzzer can be controlled.

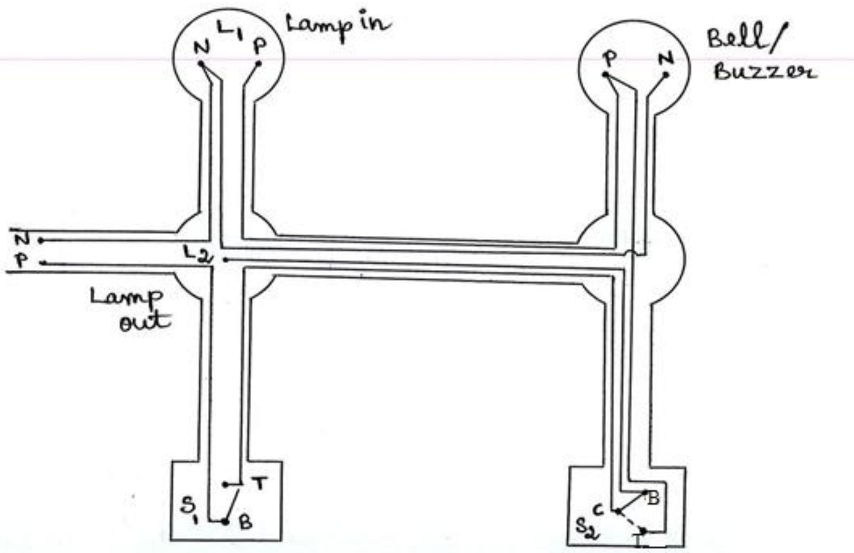
Circuit diagram:



Layout Diagram:



Wiring Diagram:



Truth Table:

Bell Switch S_1	SPDT S_2	Buzzer	Lamp In	Lamp out
ON	T	RING	ON	OFF
ON	B	OFF	OFF	ON
OFF	T/B	OFF	OFF	OFF

Result:

Thus the doctor’s room wiring has been done and the truth table is verified for all the combinations.

5. BEDROOM WIRING

Objective:

To make a Bedroom wiring.

Components required:

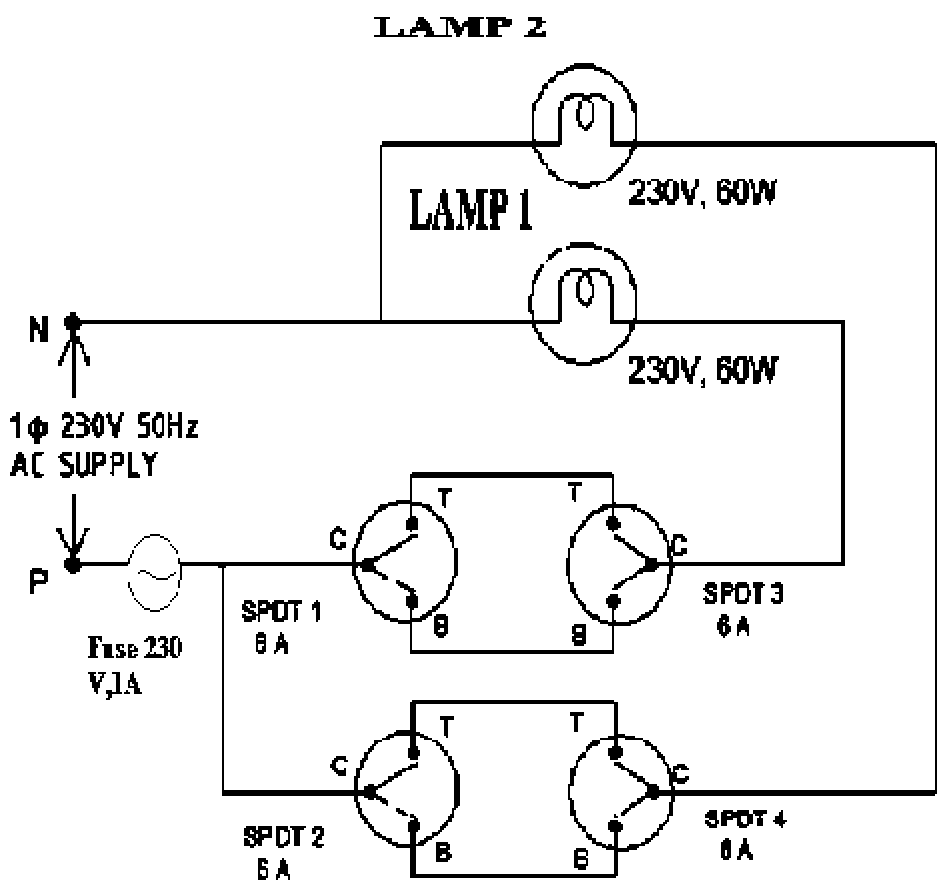
Sl. No.	Name of the components	Rating	Quantity
1	One –way junction box	19 mm	2
2	Three – way junction box	19 mm	1
3	Four - way junction box	19 mm	2
4	Switch box	4 x 4	2
5	PVC pipes	19 mm	6
6	G.I. clamps	(3/4 inch)	6
7	Screws	---	12
8	Fuse	230V, 5A	1
9	Two – way switch	230V, 10A	4
10	Batten holder	230V, 10A	2
11	Incandescent lamp	230V, (60W & 40W)	2
12	Connecting wires (multi-stand Cu.)	---	---
13	Wooden working board	---	---

Procedure:

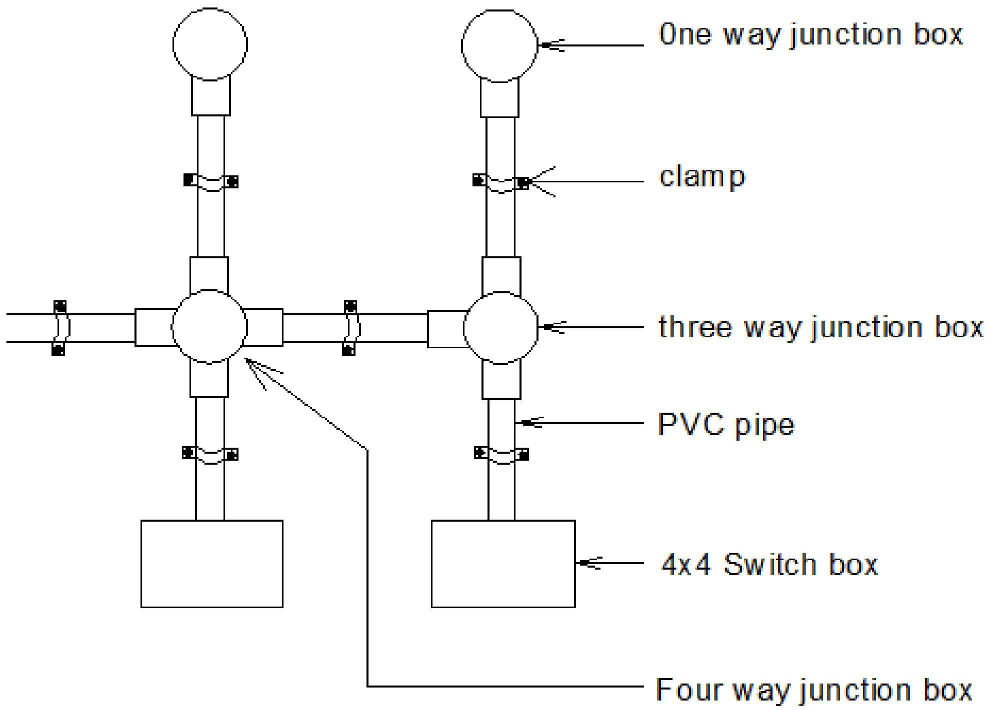
- Initially suitable junction boxes, PVC pipes and switch boxes are selected. Required connecting wires are taken.
- As per the layout diagram junction boxes, PVC pipes and switch boxes are fixed rigidly on the wooden board with the help of GI clamps.
- As per the circuit diagram the connections are given:
- The phase wire is connected to the center of the two way switch S1 (SPDT) through proper fuse.
- The bottom terminals of both the switches S1 and S2 (SPST) are interconnected.
- From the other two throw points of SPDT-1, wires are connected to the two throw points of SPDT-3. (i.e. Top terminals of SPDT-1 and SPDT-3 are connected and bottom terminals of SPDT-1 and SPDT-3 are connected.

- Again from the other throw points of SPDT-2, wires are connected to the two throw points of SPDT-4 (i.e. top terminal of SPDT-2 and SPDT-4 are connected and bottom terminals of SPDT-2 and SPDT-4 are connected).
- Center terminals of S3 and S4 are connected to one end of the batten holders B1 and B2 respectively.
- Other terminals of the batten holders are connected together and a neutral connection is taken out from the connected point.
- Connections are checked using the wiring diagram and the truth table is verified for different combinations.
- Now two lamps or (A lamp and a fan) can be controlled from two different places.

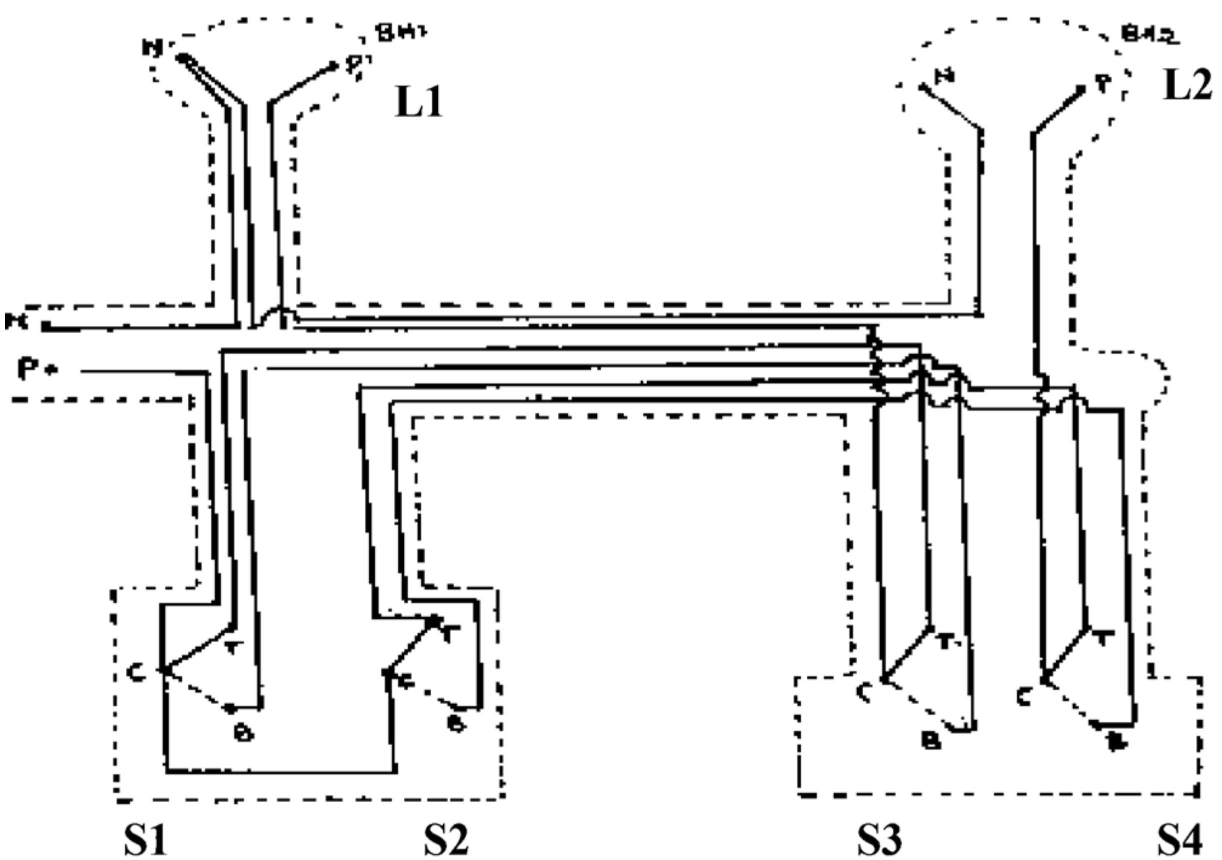
Circuit diagram:



Layout Diagram:



Wiring Diagram:



TRUTH TABLE:

S1	**S3**	**L1**	**S2**	**S4**	**L2**
T	B	OFF	T	B	OFF
T	T	ON	T	T	ON
B	B	ON	B	B	ON
B	T	OFF	B	T	OFF

Result:

Thus the lamps are controlled from two different places and truth table is verified for all combinations.

6. GODOWN WIRING

Objective:

To make a Go-down wiring

Components required:

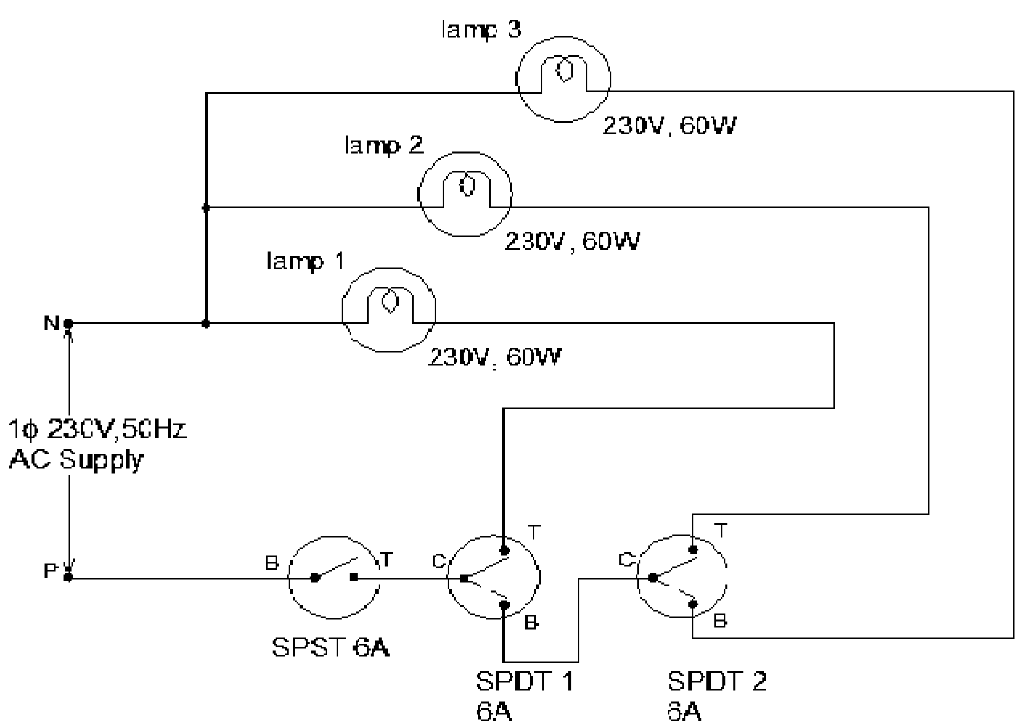
Sl. No.	Name of the components	Rating	Quantity
1	One –way junction box	19 mm	3
2	Three – way junction box	19 mm	1
3	Four - way junction box	19 mm	2
4	Switch box	4 x 4	3
5	PVC pipes	19 mm	9
6	G.I. clamps	(3/4 inch)	9
7	Screws	---	25
8	Fuse	230V, 10A	1
9	One-way switch	230V, 10A	1
10	Two – way switch	230V, 10A	2
11	Batten holder	230V, 10A	3
12	Incandescent lamp	230V, 60W	3
13	Connecting wires (multi-stand Cu.)	---	---
14	Wooden working board	---	---

Procedure:

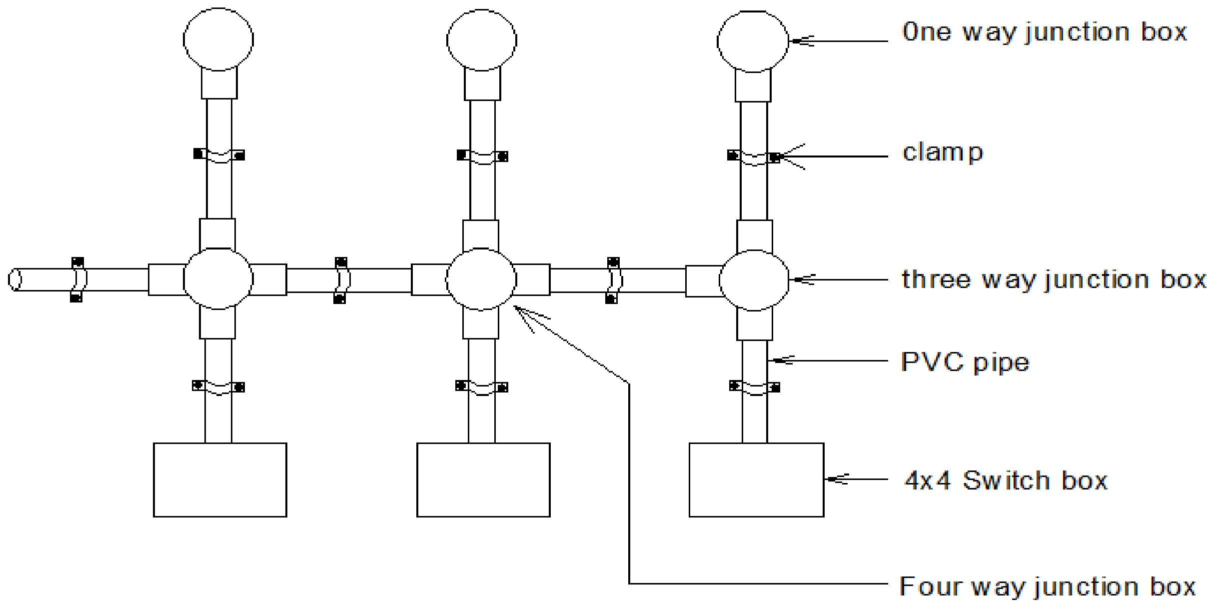
- Initially suitable junction boxes, PVC pipes and switch boxes are selected. Required connecting wires are taken.
- As per the layout diagram (3b) junction boxes, PVC pipes and switch boxes are fixed rigidly on the wooden board with the help of GI clamps.
- As per the circuit diagram (3a) the connections are given:
- The phase wire is given to the top terminal of the switch S1 (SPST) through proper fuse.
- The bottom terminal of S1 and the common terminal of switch S2 (SPDT) are connected.

- The top terminal of S2 is connected to one end of the batten holder (for L1) and the bottom terminal of S2 is connected to the common terminal of switch S3 (SPDT).
- Again the top terminal of the switch S3 is connected to the one terminal of the batten holder (for L2) and the bottom terminal of S3 is connected to any one terminal of the batten holder (for L3).
- The remaining unconnected terminals of the batten holders are connected together and taken out as neutral wire.
- Connections checked using the wiring diagram and the truth table is verified for different combinations.
- Now the three lamps can be controlled from three different places.

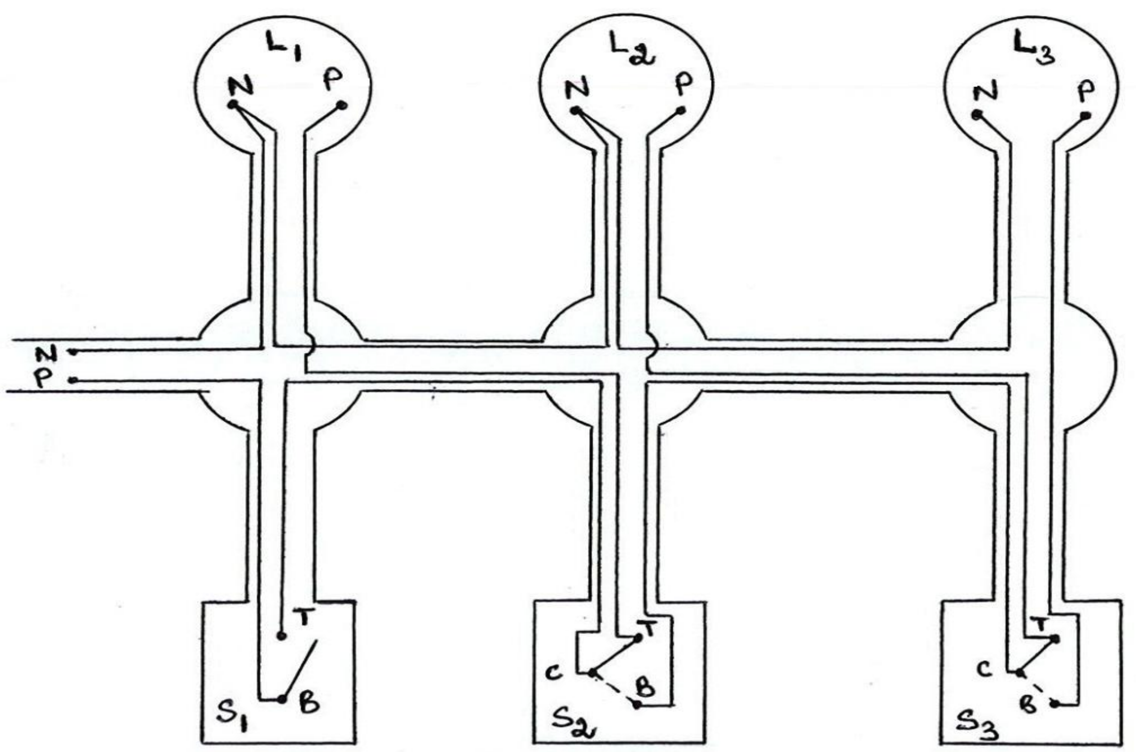
<u>Circuit Diagram:</u>



Layout Diagram:



Wiring Diagram:



Truth Table:

S_1	S_2	S_3	L_1	L_2	L_3
OFF	T / B	T / B	OFF	OFF	OFF
ON	T	T	ON	OFF	OFF
ON	B	T	OFF	ON	OFF
ON	B	B	OFF	OFF	ON
ON	B	T	OFF	ON	OFF
ON	T	T	ON	OFF	OFF
OFF	T	T	OFF	OFF	OFF

Result:

Thus the Godown wiring has been done and the truth table is verified for all the combinations.

7. FAN AND TUBE LIGHT CONNECTION-WIRING

Objective:

To make a Fan and Tube light wiring

Components required:

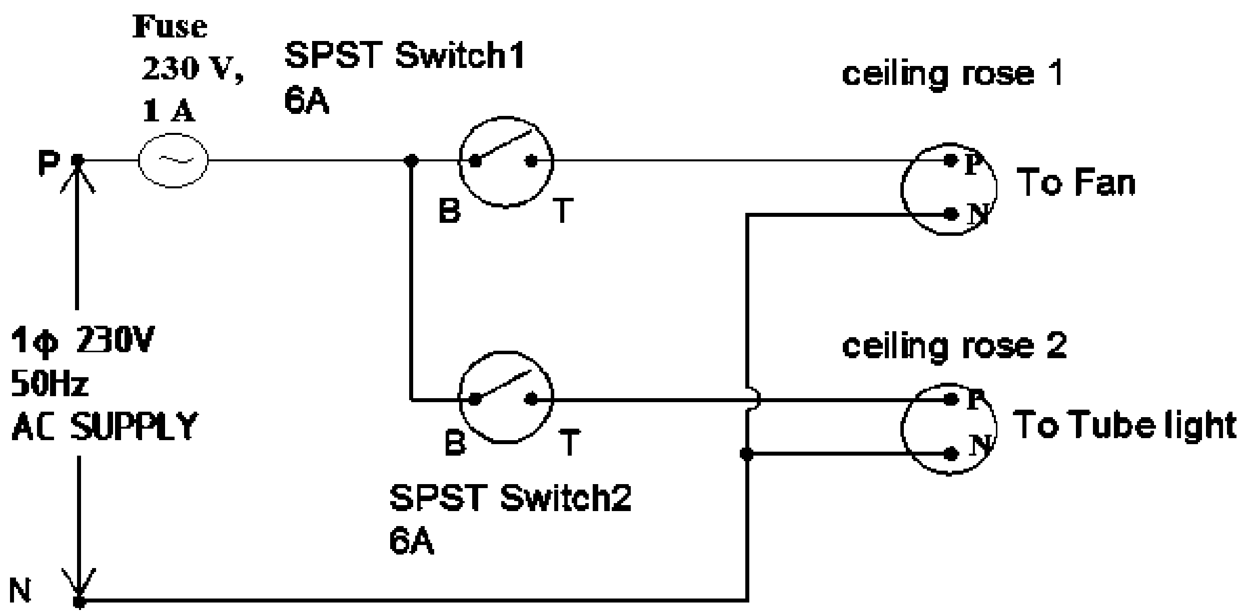
Sl. No.	Name of the component	Rating	Quantity
1	One –way junction box	19 mm	2
2	Four - way junction box	19 mm	1
3	Switch box	4 x 4	1
4	PVC pipes	19 mm	5
5	Elbow bend	19 mm	1
7	G.I. clamps	(3/4 inch)	5
8	Screws	---	14
9	Fuse	230V, 10A	1
10	One-way switch	230V, 10A	2
11	Ceiling rose	230V, 10A	2
12	Ceiling fan (1Φ, permanent capacitor induction motor)	230V, 70W	1
13	Fluorescent lamp (Tube light) along with choke, starter and holder arrangements	230V, 40W	1
14	Connecting wires (multi-stand Cu.)	---	---
15	Wooden working board	---	---

Procedure:

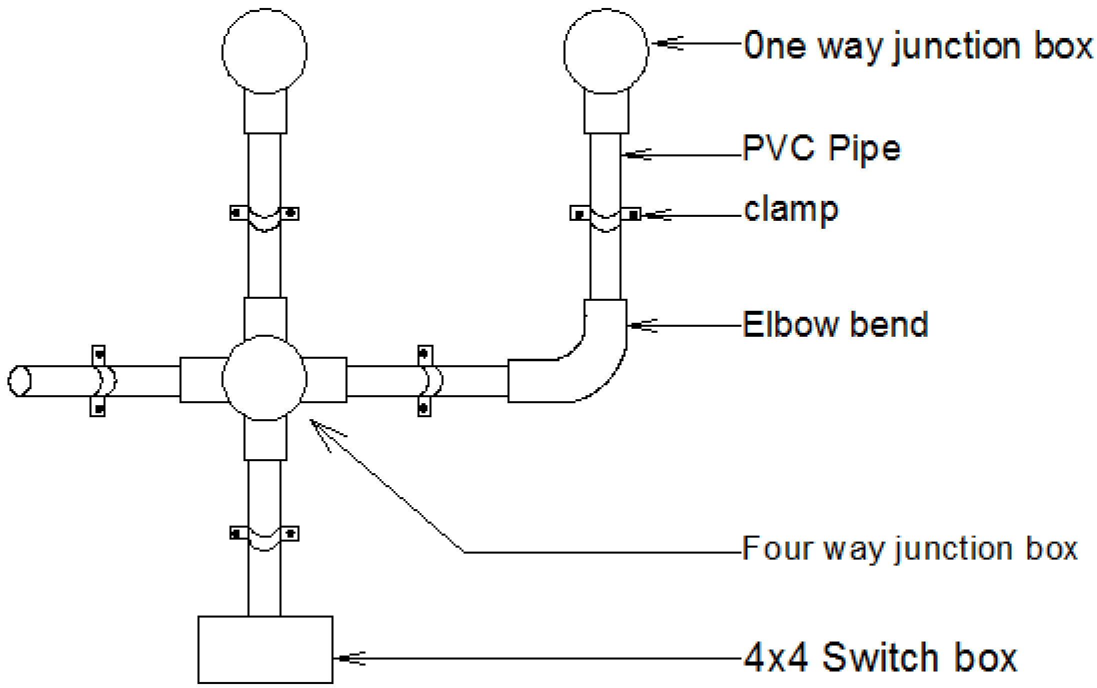
- Initially suitable junction boxes, PVC pipes and switch boxes are selected. Required connecting wires are taken.
- As per the layout diagram (4b) junction boxes, PVC pipes and switch boxes are fixed rigidly on the wooden board with the help of GI clamps.
- As per the circuit diagram (4a) the connections are given:
- The phase wire is given to the bottom terminal of the switch S1 (SPST) through proper fuse.
- The bottom terminals of both the switches S1 and S2 (SPST) are interconnected.
- From the top terminal of S1, a connection is given to any one terminal of the ceiling rose (CR1).

- Again from the top terminal of S2, a connection is given to any one terminal of the ceiling rose (CR2).
- The other two terminals left in these two ceiling roses are connected together and taken as neutral line.
- Connections checked using the wiring diagram and the truth table is verified for different combinations.
- From these ceiling roses, two individual connections are taken, to control the fan and the tube light separately.

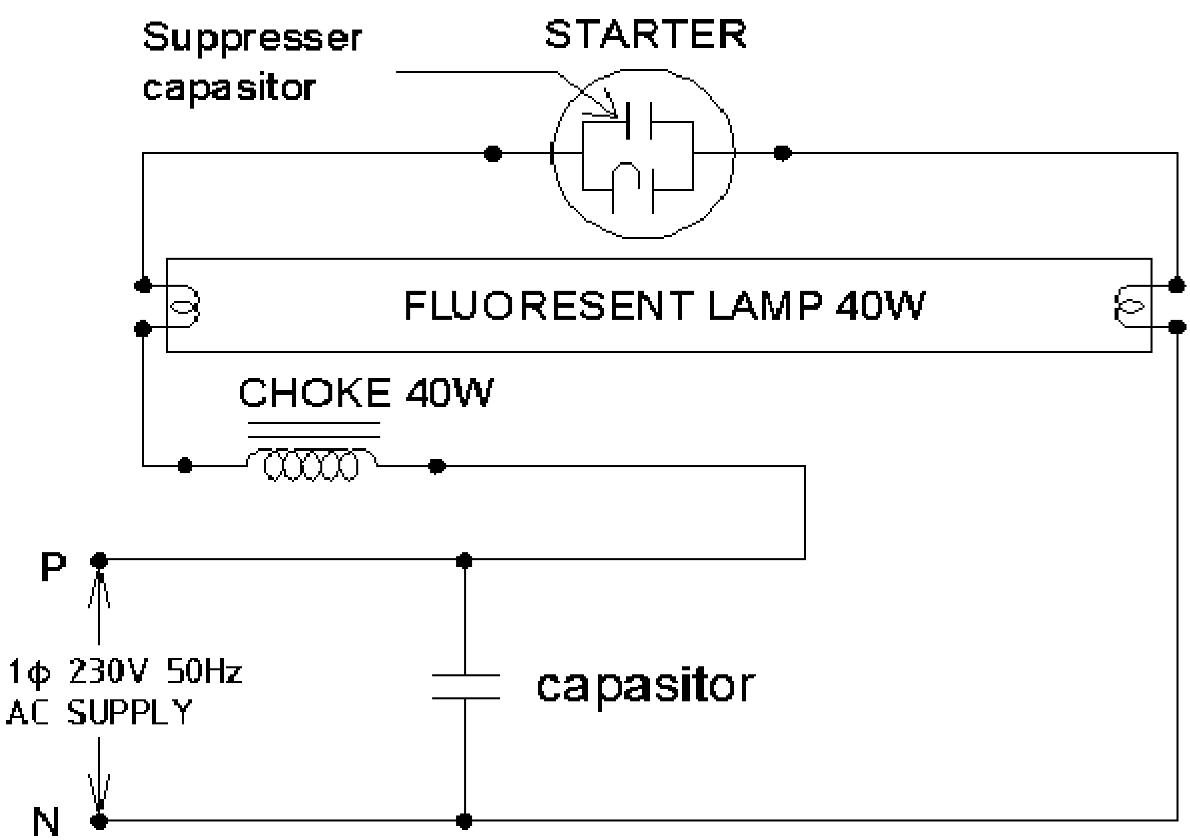
Circuit diagram:



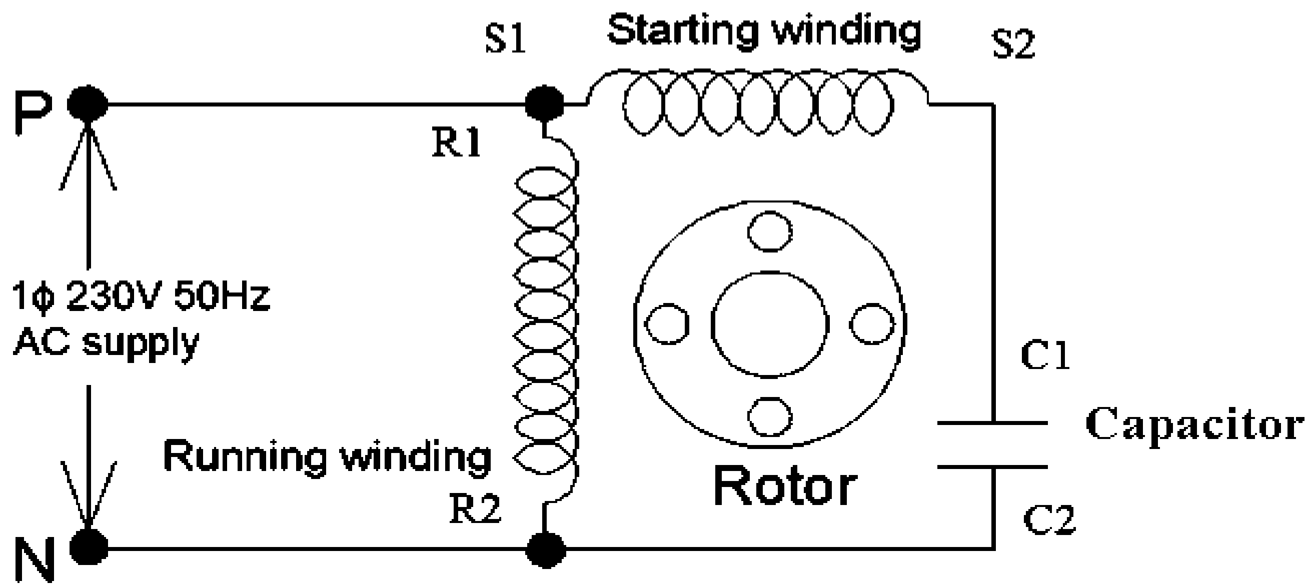
Layout diagram:



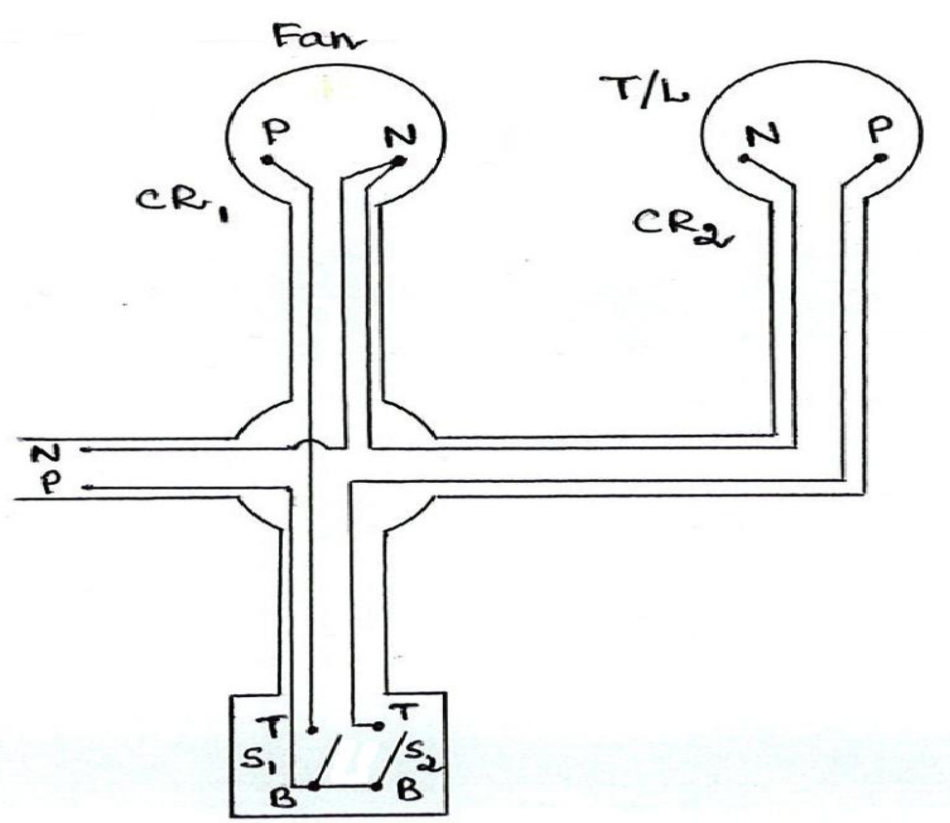
Tube light connection:



Fan connection:



Wiring Diagram:



Truth Table:

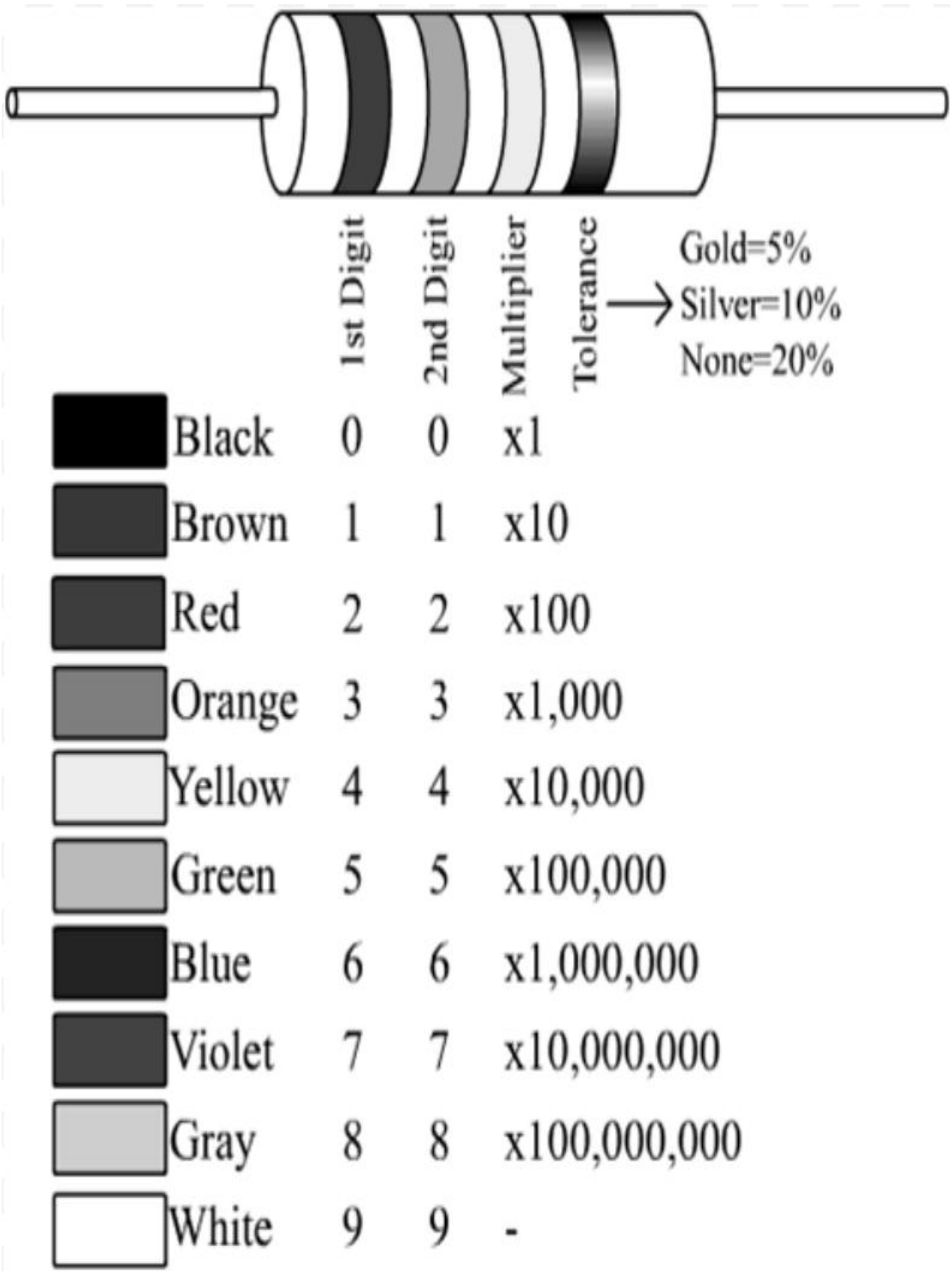
S_1	S_2	FAN	T/L
T	T	OFF	OFF
B	T	ON	OFF
T	B	OFF	ON
B	B	ON	ON

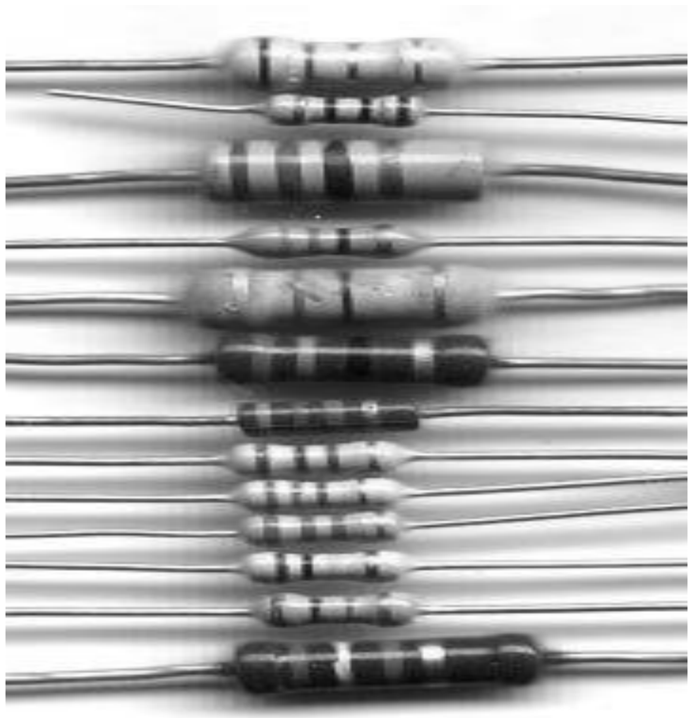
Result:

Thus the fan and the tube light connections are done and truth table is verified for all the combinations of the switches.

ELECTRONICS

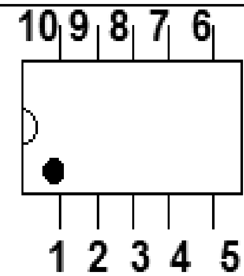
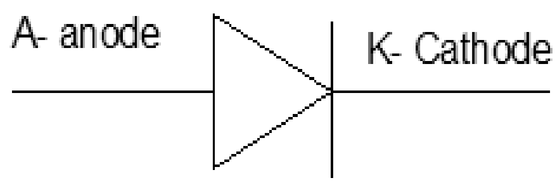
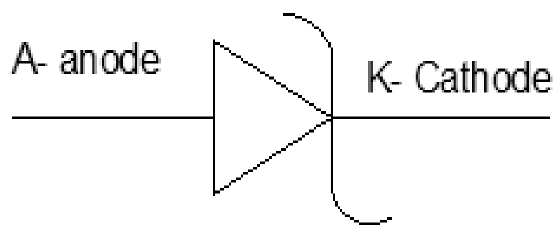
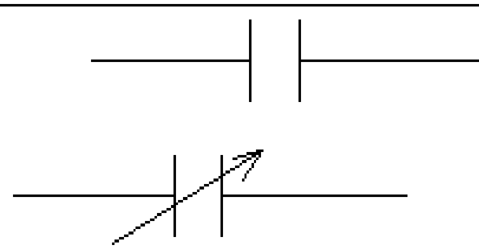
Resister colour coding

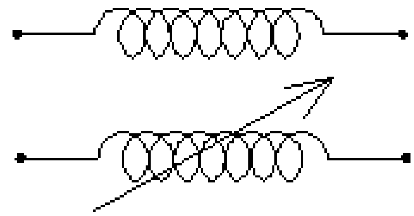
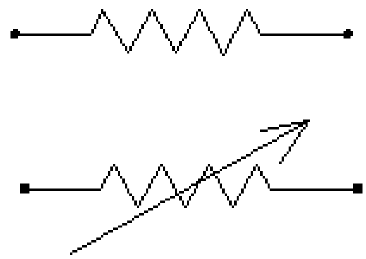
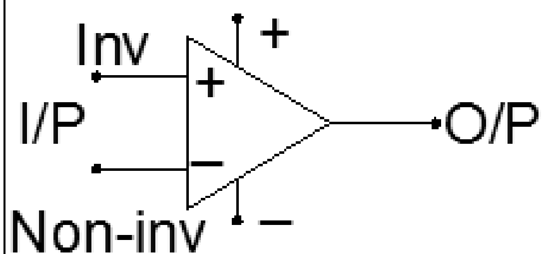
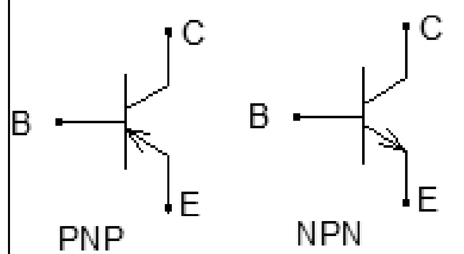


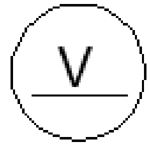
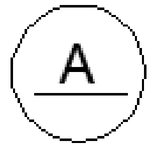
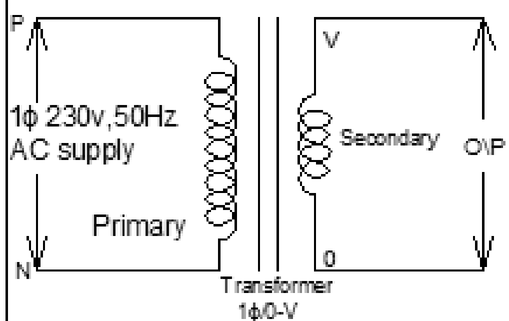
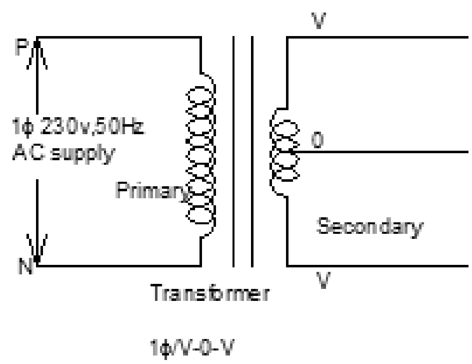


Band Color	Digit	Multiplier	Tolerance
Black	0	1	---
Brown	1	10	±1%
Red	2	100	±2%
Orange	3	1,000	±3%
Yellow	4	10,000	±4%
Green	5	100,000	---
Blue	6	1,000,000	---
Violet	7	10,000,000	---
Gray	8	100,000,000	---
White	9	---	---
Gold	---	0.1	±5%
Silver	---	0.01	±10%
None	---	---	±20%

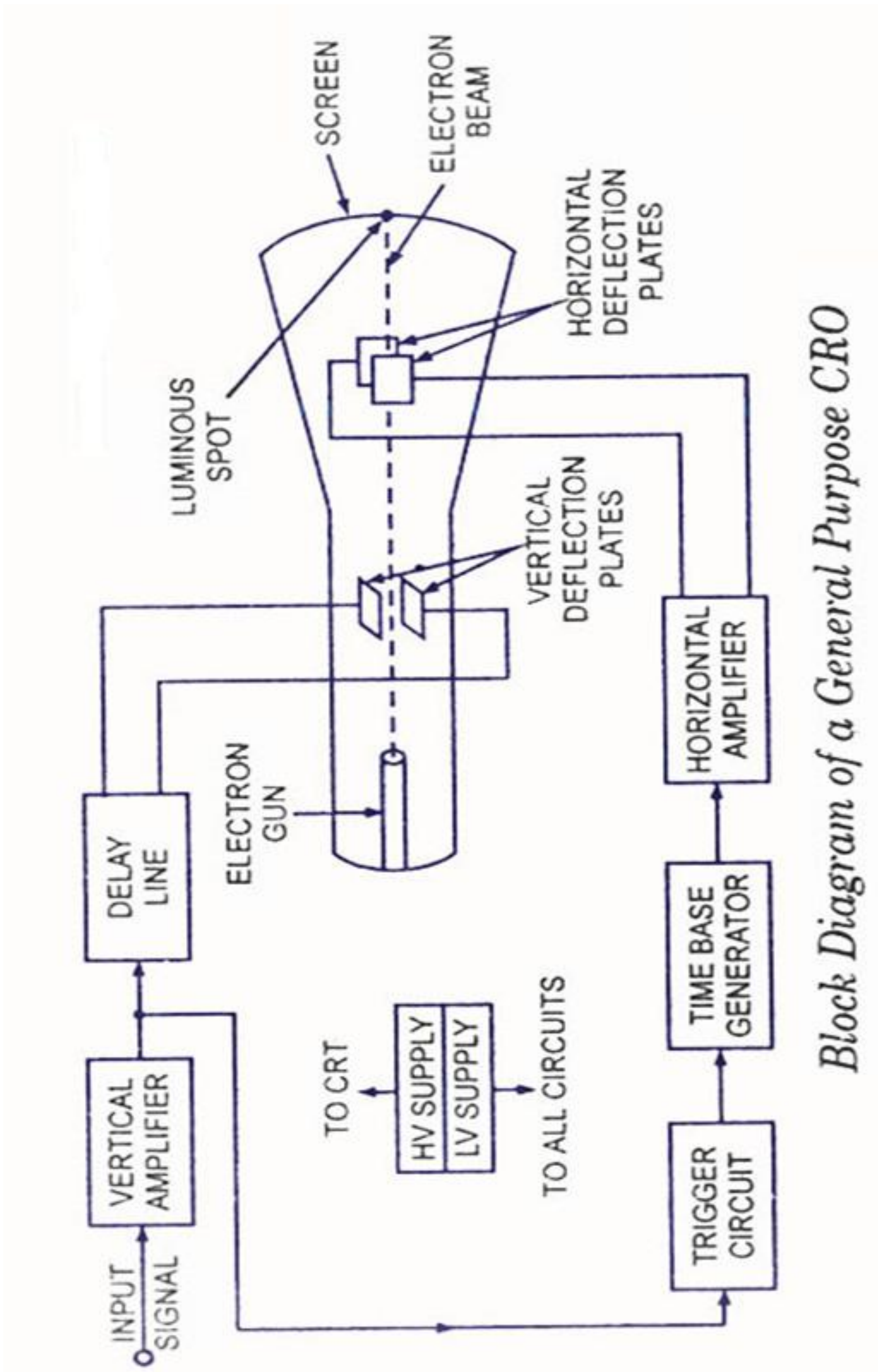
Symbols

SL NO:	Name of the symbol	Symbol
1	IC (Or) Chip	
2	PN Junction diode	
3	Zener diode	
4	Capacitor(And) variable capacitor	

SL NO:	Name of the symbol	Symbol
5	inductor (and) variable inductor	
6	Resistance (and) variable resistance	
7	OP Amp	
8	Transistor C-collector B-Base E-Emiter	

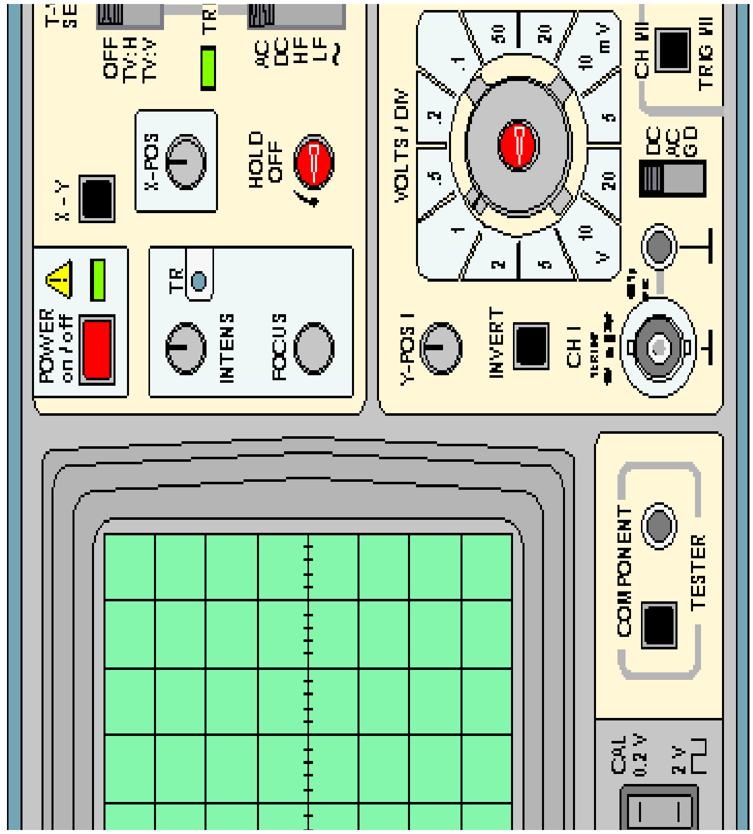
SL NO:	Name of the symbol	Symbol
9	DC Volt meter	
10	DC Ammeter	
11	Transformer	
12	Center Tapped Transformer	

BLOCK DIAGRAM OF GENERAL PURPOSE CRO



Block Diagram of a General Purpose CRO

PRACTICAL DIAGRAM OF GENERAL PURPOSE CRO



1. STUDY OF CATHODE RAY OSCILLOSCOPE

Objective:

1. To study the basic usage of Cathode Ray Oscilloscope (CRO)
2. To measure the amplitude (for DC & AC voltage signal)
3. To measure the frequency for an alternating voltage signal and the phase difference between two alternating voltage signals.

Components required:

Sl. No.	Name of the Components	Range	Quantity
1	Cathode Ray Oscilloscope (CRO)	---	1
2	Function/Signal Generator	---	1
3	BNC connector/probe (Dual)	---	1

Theory:

The Cathode Ray Oscilloscope (CRO) is a common laboratory instrument that provides accurate time and amplitude measurements of voltage signals over a wide range of frequencies. Its reliability, stability and ease of operation make it suitable as a general purpose laboratory instrument. The heart of the CRO is a cathode ray tube shown schematically in the fig.

The cathode ray is a beam of electrons which are emitted by the heated cathode (negative electrode) and accelerated towards the fluorescent screen. The assembly of the cathode, intensity grid, focus grid and accelerated anode (positive electrode) is called an electron gun. Its purpose is to generate the electron beam and control its intensity and focus. Between the electron gun and the fluorescent screen, there are two vertical deflections to the beam. These plates are thus referred to as the horizontal and vertical deflection plates. The combination of these deflections allows the beam to reach any portion of the fluorescent screen.

Wherever the electron beam hits the screen, the phosphor is excited and light is emitted from that point.

DC Voltage Measurement:

1) The vertical amplifier is grounded by selecting the ground button on the CRO.
2) The test signal is applied and there is a float for the positive signal and a downward shift for negative signal.
3) The value of dc voltage is found by multiplying the shift in divisions with the volt per division.

AC Voltage Measurement:

1) Give the signal to be measured to the corresponding channel of the CRO.
2) Measure the peak to peak (vertical) divisions of the screen.
3) Note the multiplier for the voltage i.e. volts/div.
4) Multiplication of the multiplier and the number of divisions given peak to peak voltage of the input signal.

Frequency Measurement:

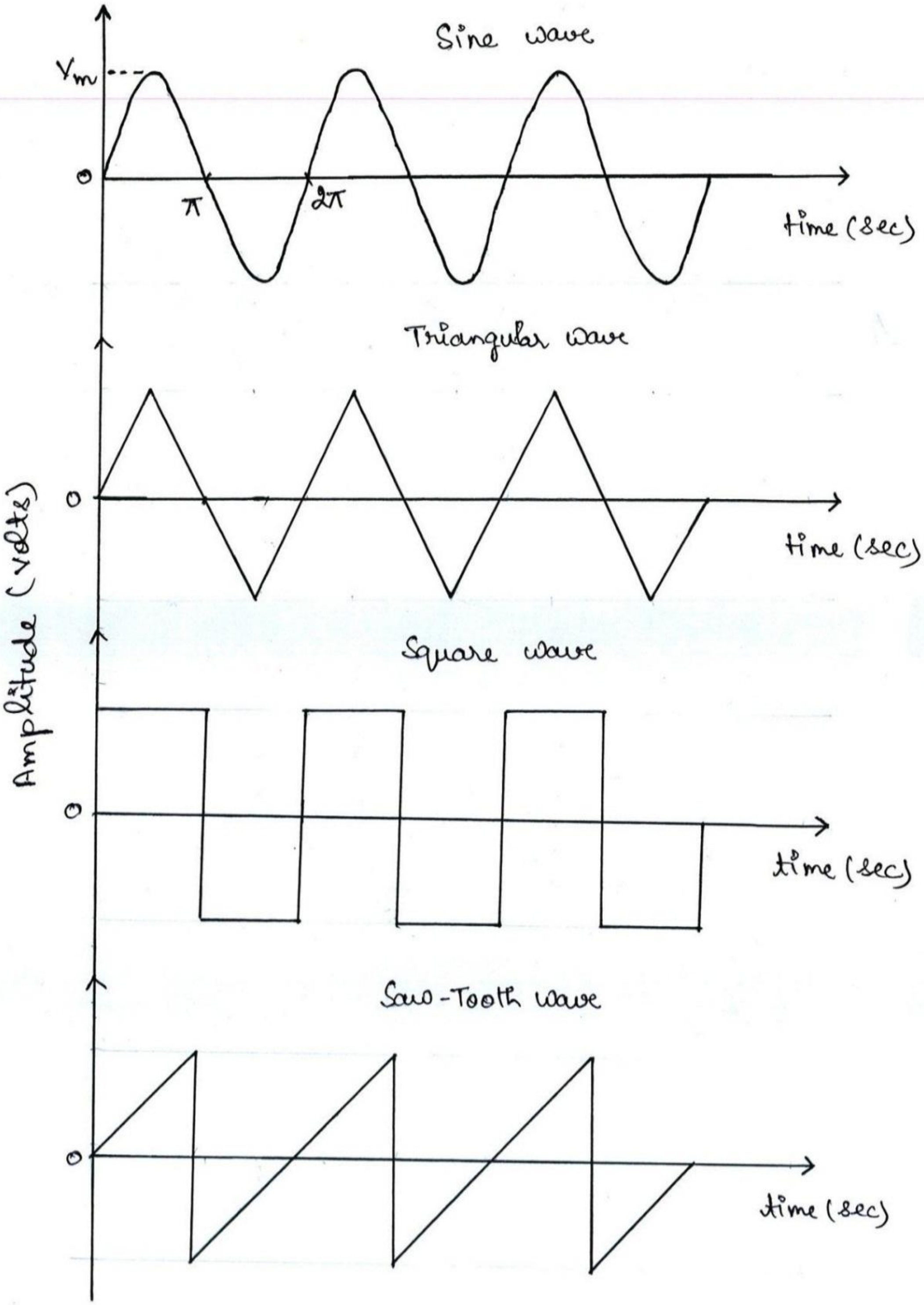
1) Give the signal to be measured to the corresponding channel of the CRO.
2) Measure the horizontal divisions of the screen for one cycle of the waveform.
3) Note the multiplier for the time base.
4) Multiplication of the multiplier and the number of divisions gives the time for one cycle
5) Inverse the time gives frequency of the signal.

Phase Measurement:

1) The two signals to be compared are given different channels.

2) The distance in division between two rising edges of the waveform is measured and multiplied with time/div. value to obtain lag in time ΔT, the time period of original signal T is also measure, the phase difference between two signal is given by,

Model Graph


Sine wave
Vm
0
π
2π
time (sec)
Triangular wave
0
time (sec)
Square wave
0
time (sec)
Saw-Tooth wave
0
time (sec)
Amplitude (volts)

Tabulation-1:

“Amplitude Measurement for different waveforms”

Sl. No.	Waveforms	No. of Divisions	Volts / Div.	Peak voltage = [(Volts / div.) x (No. of division)] Volts
1	Sine			
2	Square			
3	Triangular			
4	Saw-Tooth			

Tabulation-2:

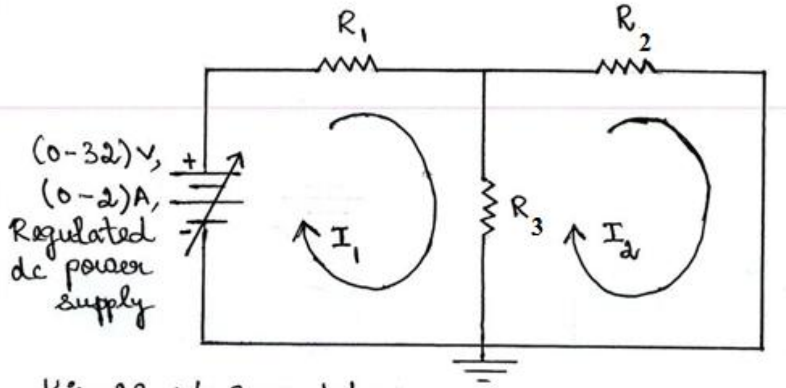
“Frequency Measurement for different waveforms”

Sl. No.	Waveforms	No. of Divisions	Time / Div. (Sec)	Time period (T) = [(Time/ div.) x (No. of division)] sec	Frequency = (1/T)Hz
1	Sine				
2	Square				
3	Triangular				
4	Saw-Tooth				

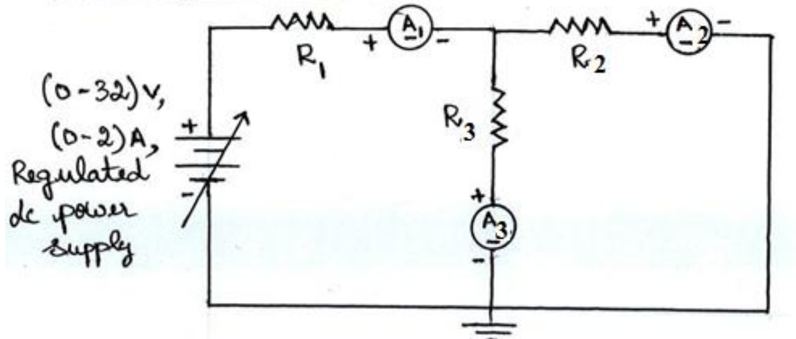
Result:

Thus the basic usage of the CRO is studied. And also the amplitude, frequency and phase difference measurement for a given waveform are studied.

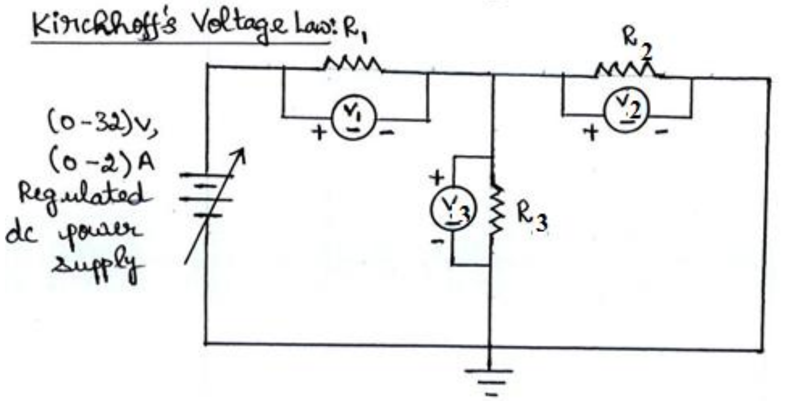
Given Circuits:



Kirchhoff's Current Law:



Kirchhoff's Voltage Law:



2. VERIFICATION OF KIRCHHOFF'S LAWS

Objective:

To verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) for the given circuit and to compare the practical results with the theoretical results.

Equipment's / Components required:

Sl. No.	Name of the Equipment/Component	Range	Quantity
1	DC Regulated Power Supply	(0-32)V, (0-2)A	1
2	Ammeter	(0-100)mA	3
3	Voltmeter	(0-30)V	3
4	Bread Board	---	1
5	Resistors	(As per the given circuit)	3
6	Connecting wires (Single stand, G.I)	---	---

Theory:

Kirchhoff's Laws-Explanation:

Entire electric circuit analysis is based on these laws only. In early 1st century, Gastav Kirchhoff, a German scientist, gave his findings with electrical circuit in a set of two laws-a current and a voltage law-which are together known as Kirchhoff's laws.

a) First Law (i.e.) Kirchhoff's Current Law (KCL)

Statement: The algebraic sum of currents meeting at a junction or node in an electrical circuit is zero.

Explanation: An algebraic sum is one in which the sign of the quantity is taken into account. Consider five conductors, carrying current I_1, I_2, I_3, I_4 and I_5 meeting at point O as shown in fig. below.

If we assume the currents flowing towards point O as positive, then, the currents flowing away from pint O will have negative sign. Now, applying Kirchhoff's current law at junction O, we get

$$(+I_1) + (-I_2) + (+I_3) + (-I_4) + (+I_5) = 0$$

$$I_1 - I_2 + I_3 - I_4 + I_5=0$$

$$I_1 + I_3 + I_5 = I_2 + I_4$$

ie. sum of the incoming currents = sum of the outgoing currents.

The above law (KCL) can also be stated as:

The sum of the currents flowing towards any junction in an electric current is equal to the sum of the currents flowing away from that junction.

Validity of KCL: KCL is true because electric current is merely flow of electrons and they cannot accumulate at any point in the circuit.

a) Second Law – Kirchhoff's Voltage Law (KVL):

Statement: In any closed circuit or mesh or loop, the algebraic sum of all the voltages taken around is zero.

Validity of KVL: If we start from any point in a closed circuit and go back to that point, after going round the circuit, there is no increase or decrease in the potential at that point. This means the sum of emf's and sum of voltage drops or rise met on the way is zero

Algebraic emf and Voltage Drops:

While applying KVL, algebraic sums are involved. So, it is necessary to assign proper signs to the emf's and voltage drops. The following sign conversion may be used.

A rise in potential can be positive while a fall in potential can be considered negative. The reverse is also possible and both conversions will give the same result.

Tabulation-1:

"Kirchhoff's Current Law"

Applied Voltage	Theoretical Values			Practical Values		
	I_1 (mA)	I_2 (mA)	I_3 (mA)	I_1 (mA)	I_2 (mA)	I_3 (mA)

Tabulation-2:

"Kirchhoff's Voltage Law"

Applied Voltage	Theoretical Values			Practical Values		
	V_1 (V)	V_2 (V)	V_3 (V)	V_1 (V)	V_2 (V)	V_3 (V)

i) If we go from a +ve terminal of the battery or source to the –ve terminal there is a fall in potential and so the emf should be assigned negative sign. If we, go from –ve terminal of the battery or source to the +ve terminal, then, there is rise in potential and so the emf should be given positive sign. It is clear that sign of emf is independent of the direction of current through it.

ii) When current flows through a resistor, there is a voltage drop across it. If we go through the resistance in the same direction as the current there is a fall in potential (current flows from higher potential point to lower potential point). So, the sign of this voltage drop is negative. If we go opposite to the direction of current flow, there is a rise in the potential and hence, this voltage drop should be given positive sign. It is clear that the sign of voltage drop (i.e. IR drop) depends upon the direction of current flow and is independent of the polarity of the emf in the circuit under consideration.

Procedure:

1. Required equipment's/components are collected as per the circuit given.
2. Connections are given in the bread board as per the given circuit.
   (Note: Polarities of the measuring meters should be considered)
3. Apply some voltage and tabulate the corresponding values shown in the ammeters or voltmeters (depending upon the law to be verified).
4.
   a) For KCL: Apply the Kirchhoff's Current Law at each node and write the governing equations and solve for the currents.
   b) For KVL: Apply the Kirchhoff's Voltage Law at each mesh/loop and write the governing equations and solve for the voltages.
5. Repeat the steps (3) and (4) for other some voltage levels (say five readings).
6. Compare the practical results with the theoretical values.

Result:

Thus the Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) for the given circuit are verified by comparing the practical values with the theoretical values. The results are found to be nearly equal.

3. CHARACTERISTICS OF PN JUNCTION DIODE

Aim:

To find the VI characteristics of a given PN junction diode.

Components required:

Sl. No.	Name of the Component	Range	Quantity
1	DC Regulated Power Supply	(0-32)V, (0-2)A	1
2	Ammeter	(0-30)mA (0-500) µA	1 1
3	Voltmeter	(0-15)V (0-1)V	1 1
4	Bread Board	---	1
5	Resistors	100Ω	1
6	PN junction diode (IN 4001)	---	1
7	Connecting wires (Single stand, G.I)	---	---

Formula used:

1. Forward static resistance $=V_f/I_f$ Ω
2. Forward dynamic resistance $= \Delta V_f/\Delta I_f$ Ω
3. Reverse static resistance $= V_r/I_r$Ω
4. Reverse dynamic resistance $= \Delta V_r/\Delta I_r$ Ω

Where,

V_f Forward voltage

I_f Forward current

V_r Reverse voltage

I_r Reverse current

ΔV_f Change in forward voltage

ΔI_f Change in forward current

ΔV_r Change in reverse voltage

ΔI_r Change in reverse current

Procedure:

Forward bias:

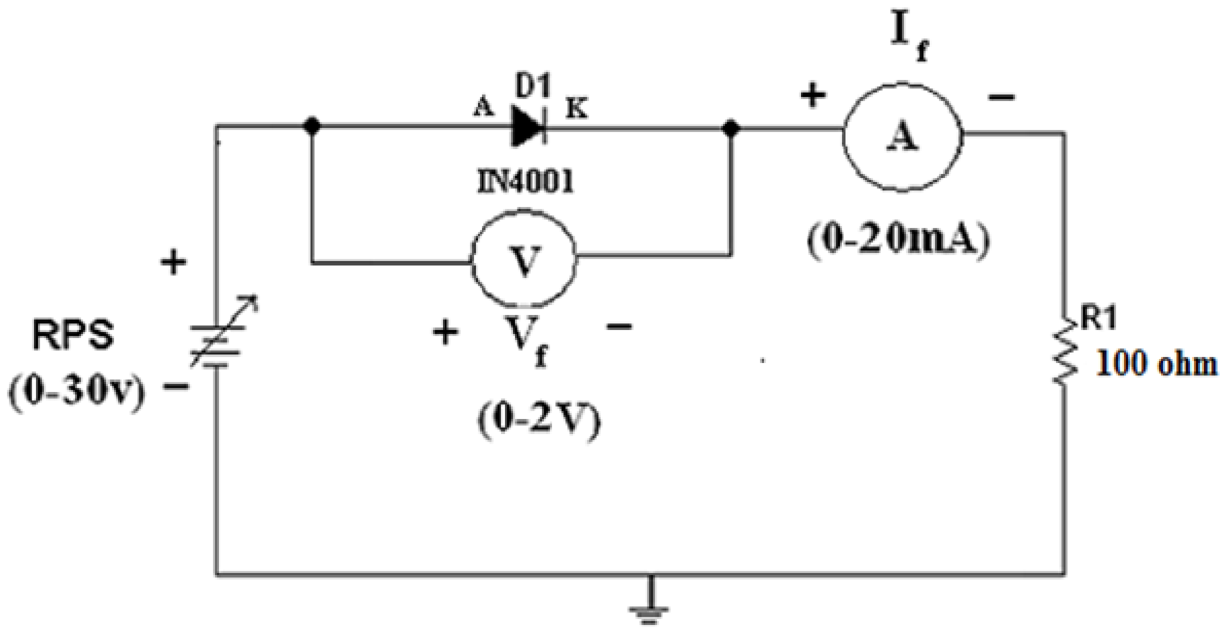
1. Connections are made as per the circuit diagram.
2. The regulated power supply is connected with diode and the voltage is straightly increased from zero. At some forward voltage, the potential barrier is completely eliminated and current starts flowing in the circuit.
3. Now, increase the forward voltage and note the corresponding current flow through the diode. The current rises slowly with rise in applied voltage.
4. Draw the graph of forward voltage vs forward current. The static and resistance can be calculated.

Reverse bias:

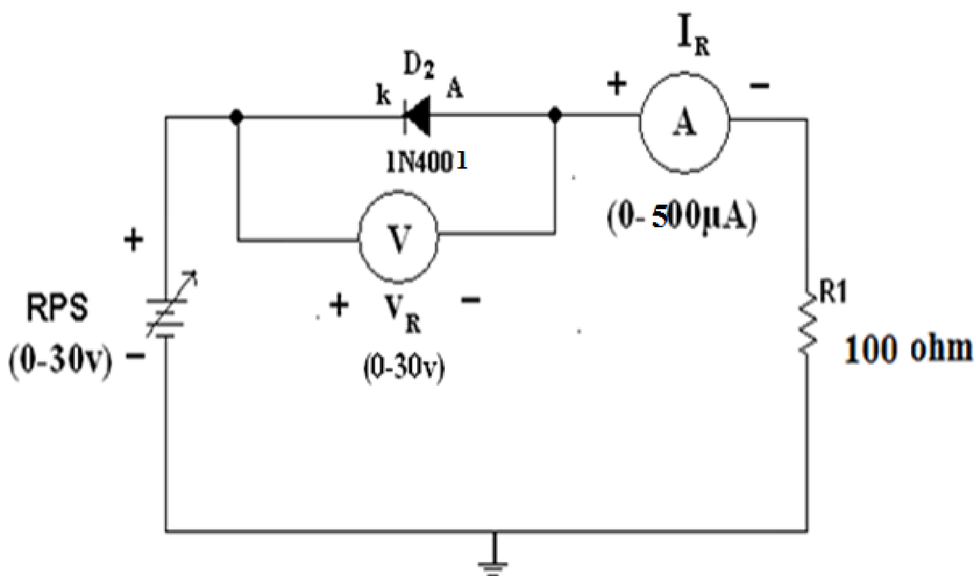
1. The RPS is connected with diode and the voltage is increased from zero.
2. The applied voltage is increases such that a small current flows in the circuit.
3. The applied voltage is still increased to get rapid increase in the current.
4. Draw the graph of reverse voltage and reverse current.

Circuit diagram:

Forward Bias



Reverse Bias:



Observation Table:

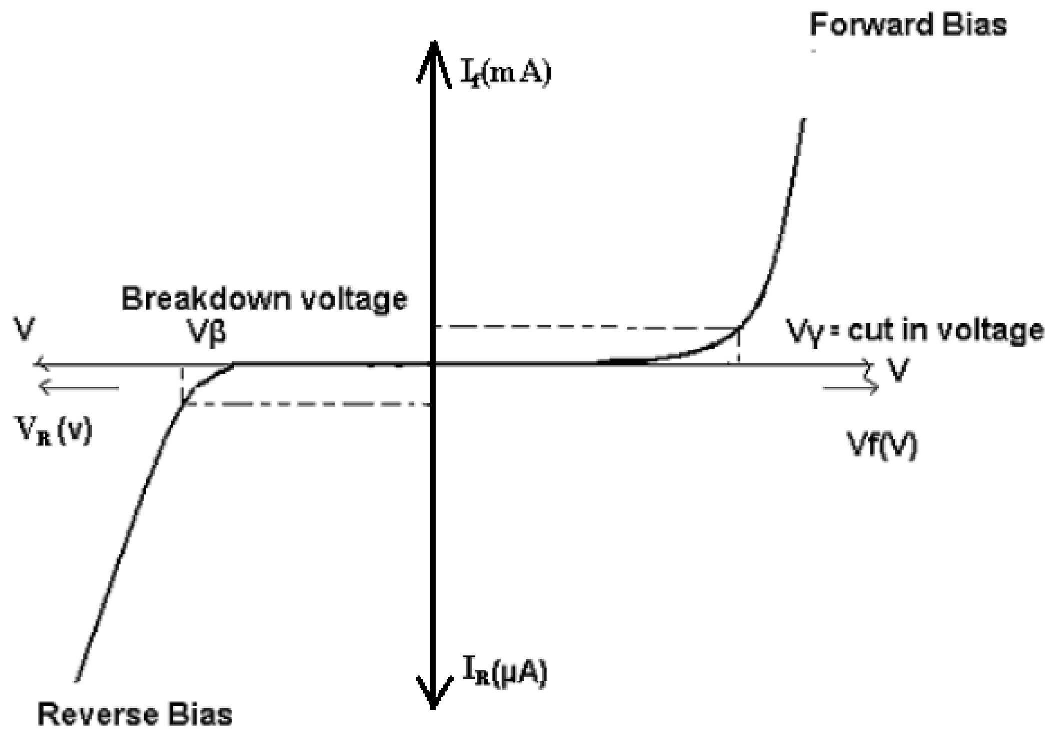
Forward bias:

Sl.No	Applied voltage	Current (I_F) in mA	Voltage (V_F) in V
1	0.1		
2	0.2		
3	0.3		
4	0.4		
5	0.5		
6	0.6		
7	0.7		
8	0.8		
9	1		

Reverse Bias:

Sl.No	Applied voltage	Current (I_R) in µA	Voltage (V_R) in V
1	1		
2	2		
3	3		
4	4		
5	6		
6	8		
7	10		

Model wave form:



Result:

A suitable experiment is conducted to study the VI characteristics of a PN junction diode and its corresponding parameters are found from the experiment.

1. Forward static resistance=………………. Ω
2. Forward dynamic resistance=………………. Ω
3. Reverse static resistance=………………. Ω
4. Reverse dynamic resistance =………………. Ω

4. STUDY OF RECTIFIERS

Aim:

To construct half wave rectifier circuits, with and without filter. To calculate the ripple factor for the output waveforms.

Components required:

Sl. No.	Name of the Component	Rating	Quantity
1	Step down Transformer& Step down center trapped Transformer	230V/0-6V& 230V/6v-0-6V	1
2	Resistors	1 kΩ	1
3	Capacitor	100µF/25v	1
4	Diode IN4007	230V, 1A	4
5	Bread Board	---	1
6	Cathode Ray Oscilloscope (CRO)	---	1
7	Connecting wires (Single stand, G.I)	---	---

Theory:

A rectifier is defined as an electronic device used for converting ac voltage into unidirectional voltage. A rectifier utilizes unidirectional conduction device like vacuum diode or PN junction diode.

Rectifiers are classified depending upon the period of conduction as half wave rectifier and full wave rectifier.

Half-Wave rectifier:

It converts an ac voltage into a pulsating dc voltage using only one half of the applied ac voltage. The rectifying diode conducts during one half of the ac cycle only. The basic circuit and waveforms of a half-wave rectifier.

Let V_i be the voltage to the primary of the transformer and given by the equation

$$V_i = V_m \sin\omega t;\ V_m >> V_r \text{ where,}$$

V_r is the cut-in voltage of the diode.

During the positive half cycle of the input signal, the anode of the diode becomes positive with respect to the cathode and hence the diode D conducts.

For an ideal diode, the forward voltage drop is zero. So the whole input voltage will appear across load resistance R_L.

During negative half cycle of the input signal, the anode of the diode becomes negative with respect to the cathode and hence the diode D does not conduct. For an ideal diode, the impedance offered by the diode is infinity. So, the whole input voltage appears across the diode D. Hence the voltage drop, across R_L is zero.

Efficiency (η):

The ratio of dc output power to ac input power is known as rectifier efficiency (η).

$$\eta = (\text{output power}) / (\text{ac input power})$$

The maximum efficiency of a half wave rectifier is 40.6%.

<u>Ripple factor (Γ):</u>

The ratio of the rms value of ac component to the dc component in the output is known as ripple factor (Γ).

$$\Gamma = (\text{rms value of ac component}) / (\text{dc value of component})$$

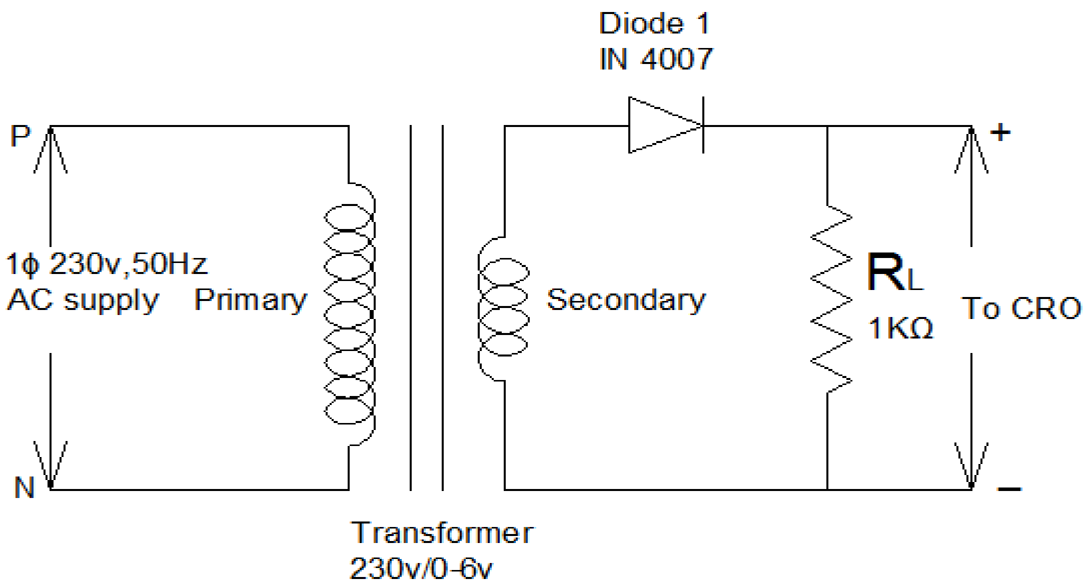
The ripple factor for half wave rectifier is 1.21.

Peak Inverse voltage (PIV):

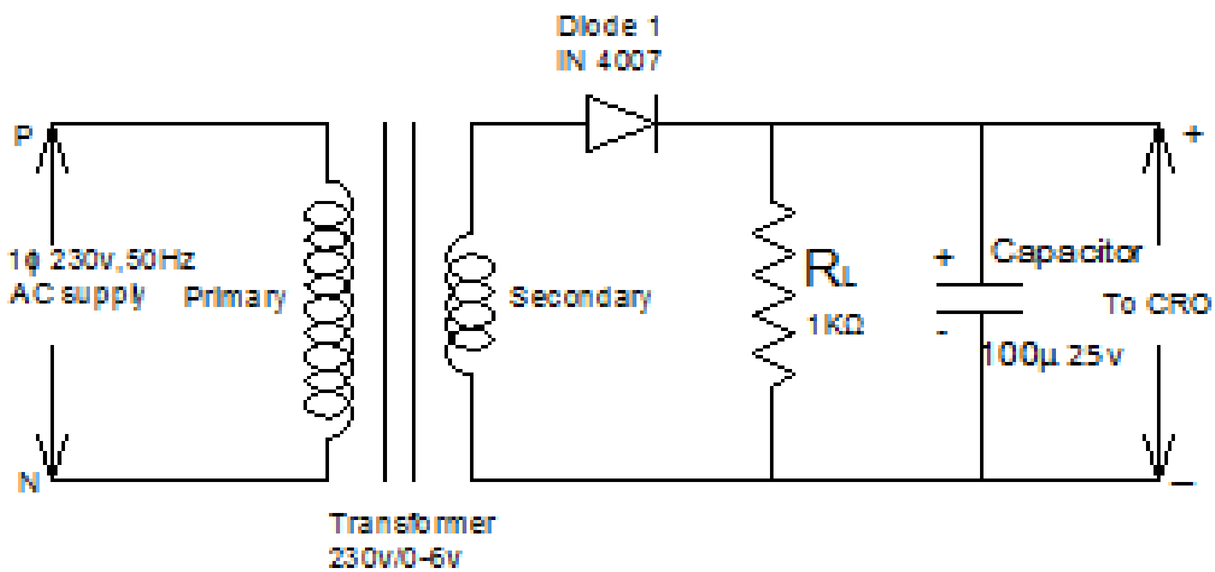
It is defined as the maximum reverse voltage that a diode can withstand without destroying the junction. For half-wave rectifier PIV is V_m.

Half wave rectifiers:

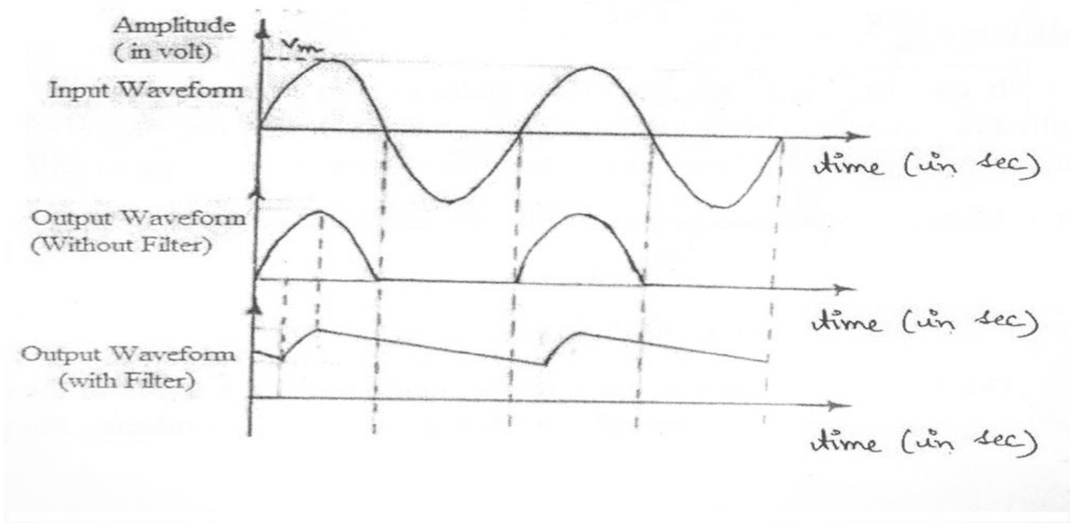
Without filter:



With filter:



Model graph:



Tabulation:
“Study of Rectifiers

<table>
<tr><th rowspan="3">Type of Rectifier</th><th colspan="2">Input Waveform</th><th colspan="4">Output Waveform</th></tr>
<tr><th rowspan="2">Amplitude (volts)</th><th rowspan="2">Time (sec)</th><th colspan="2">Without Filter</th><th colspan="2">With Filter</th></tr>
<tr><th>Amplitude (volts)</th><th>Time (sec)</th><th>Amplitude (volts)</th><th>Time (sec)</th></tr>
<tr><td rowspan="3">Half Wave</td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td>Vmax.=</td><td rowspan="2">Charging time=</td></tr>
<tr><td>Vmin.=</td></tr>
<tr><td>Avg.=</td><td>Discharging time=</td></tr>
</table>

Procedure:

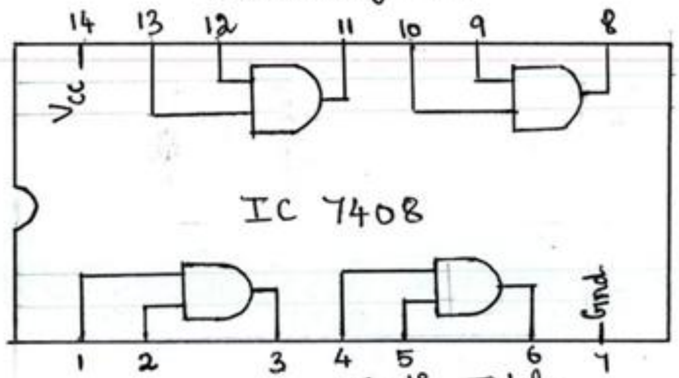
1. Required components are selected.
2. Connections are given in the bread board as per the relevant circuit diagram.
3. AC input is given to the rectifier circuit, with the help of 230V/6-0-6V step down transformer.
   (Note: If the diode gets heated up heavily, then switch off the supply and check the connections of anode and cathode terminals)
4. Initially, the amplitude and frequency of the input waveform to the rectifier circuit is noted in the tabulation given.
5. The output waveform is to be measured across the load resistor (without filter)is seen in the CRO(whose amplitude and frequency are to be noted).
6. Next connect the filter across the load and tabulate the readings.
7. Plot the graph for the input as well as the output waveform (both for with and without filter)

Result:

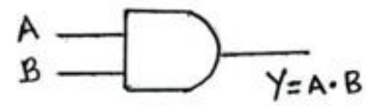
Thus the half rectifier circuits are constructed and the output waveforms for with and without filter are obtained. Also the ripple factor for half waverectifiers is calculated.

AND gate: (a)

Pin Diagram



Symbol

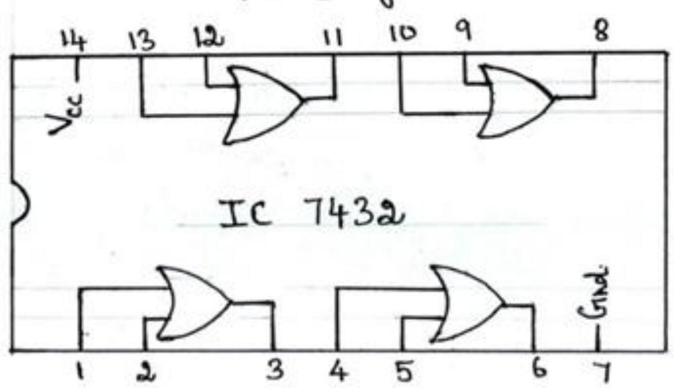


Truth Table

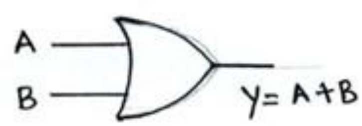
A	B	Y= A·B
0	0	0
0	1	0
1	0	0
1	1	1

OR gate: (b)

Pin Diagram



Symbol



Truth Table:

A	B	Y= A+B
0	0	0
0	1	1
1	0	1
1	1	1

5. STUDY OF LOGIC GATES

a) VERIFICATION OF TRUTH TABLE OF LOGIC GATES

Aim:

To verify the truth table of AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR logic gates.

Equipments / Components required:

Sl. No.	Name of the Equipment/Component	Range/Rating	Quantity
1	Digital Trainer Kit	---	1
2	IC 7408 (AND gate)	5V-12V dc	1
3	IC 7432 (OR gate)	5V-12V dc	1
4	IC 7404 (NOT gate)	5V-12V dc	1
5	IC 7400 (NAND gate)	5V-12V dc	1
6	IC 7402 (NOR gate)	5V-12V dc	1
7	IC 7486 (EX-OR gate)	5V-12V dc	1
8	IC 74266 (EX-NOR gate)	5V-12V dc	1
9	Connecting wires (Single stand, G.I)	---	---

Theory:

The elements for performing logic functions are usually called gates. The most common logic gates are AND, OR& NOT gates.

AND Gate:

The AND gate performs logical multiplication, commonly known as AND function. The AND gate is composed of two or more inputs and a single output.

The output of AND gate is high only when all the inputs are high. When any of the inputs is low, the output is low. Logical symbol of the AND gate is shown in the fig. (a). The electrical equivalent circuit of AND gate is shown in the fig. below where two switches A and B are connected in series.

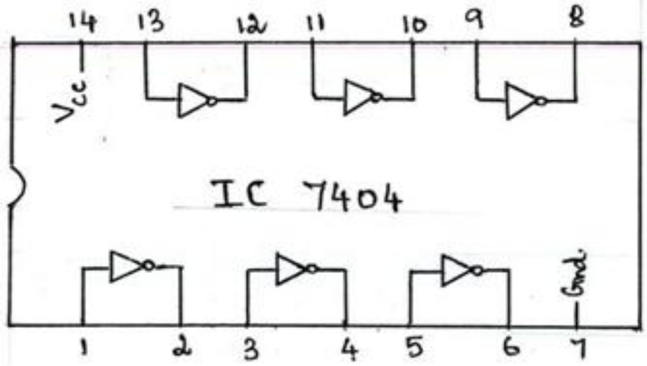
If both A and B are closed then only output will result. The logical operation of two input AND gate is described in the truth table shown in fig (a).

The elements for performing logic functions are usually called gates. The most common logic gates are AND, OR& NOT gates

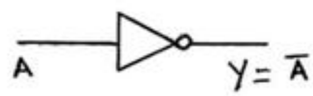
NOT gate:

(c)

Pin Diagram



Symbol



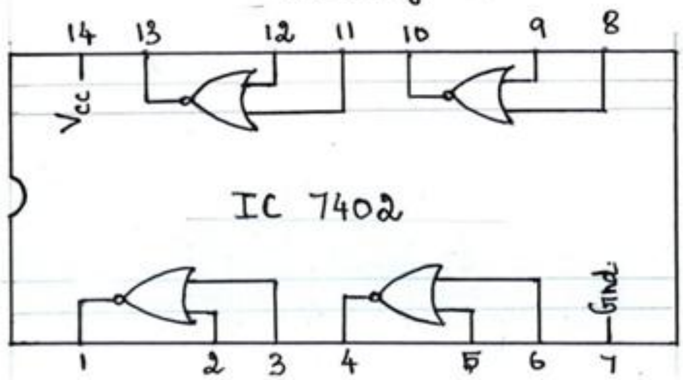
Truth Table

A	$Y = \overline{A}$
0	1
1	0

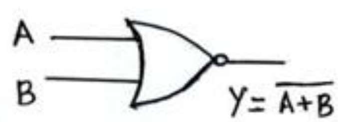
NOR gate:

(d)

Pin Diagram



Symbol



Truth Table:

A	B	$Y = \overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

AND Gate:

The AND gate performs logical multiplication, commonly known as AND function. The AND gate is composed of two or more inputs and a single output.

The output of AND gate is high only when all the inputs are high. When any of the inputs is low, the output is low. Logical symbol of the AND gate is shown in the fig. (a). The electrical equivalent circuit of AND gate is shown in the fig. below where two switches A and B are connected in series.

If both A and B are closed then only output will result. The logical operation of two input AND gate is described in the truth table shown in fig (a).

OR Gate:

The OR gate performs logical addition, commonly known as OR function. The OR gate has two or more inputs and only one output.

The operation of OR gate is such that a high (1) on the output is produced when any of the inputs is high (1). The output is low (0) only when all the inputs are low (0).The electrical equivalent circuit of an OR gate is shown in fig. (b), where switches A and B are connected in parallel with each other.

If either A, B or both are closed, then the output will result. The logic symbol for OR gate is shown in fig. (b). The logical operation of two input AND gate is described in the truth table shown in fig (b).

NOT Gate:

The NOT gate performs a basic logic function called inversion or complementation. The purpose of gate is to change one logic level to opposite level. It has one input and one output.

When a high level is applied to an inverter input, a low level will appear at its output and vice versa.

The logic symbol for the inverter is shown in fig. (c).

NOR Gate:

NOR is the contraction of NOT-OR. It has two or more inputs but only one output. When any of the inputs is high, the output is low. Only when all the inputs are low, the output is high. The logical symbol of NOR gate is shown in the fig. (d). The truth table for the NOR gate is also shown.

NAND Gate:

NAND is a contraction of NOT-AND. It has two or more inputs and only one output. When all the inputs are high, the output is low. If any of the input is low, the output is high. The logic symbol for the NAND gate is shown in fig. (e), the truth table for the NAND gate is also shown.

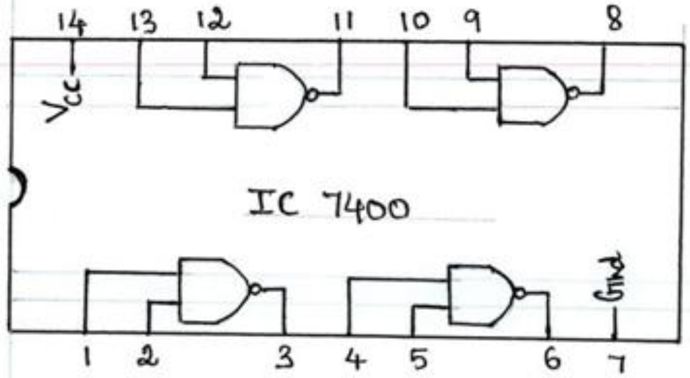
Exclusive-OR (XOR) & Exclusive-NOR (XNOR) Gates:

These gates are usually formed from the combination of the other logic gates. However, because of their function importance, these gates are treated as basic gates with their own unique symbols. The standard symbol and truth table for XOR and XNOR gates are shown in the fig. (f) & (g) respectively. The Exclusive-OR is an "inequality" function and the output is HIGH (1) when the inputs are not equal to each other. Conversely, the Exclusive-NOR is an "equality" function and the output is HIGH (1) when the inputs are equal to each other. For the XOR gate function is expressed as.

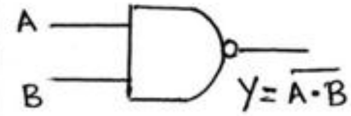
(e)

NAND gate:

Pin Diagram



Symbol



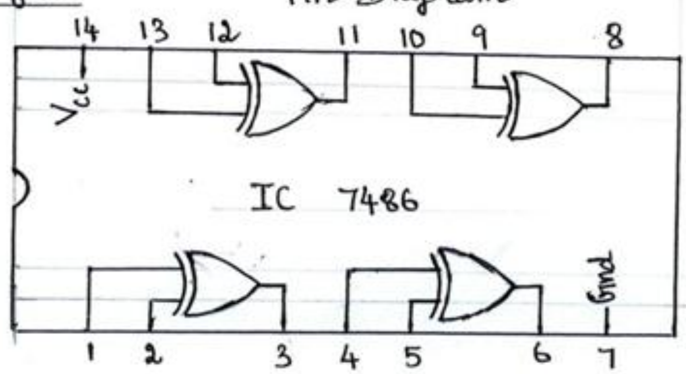
Truth Table

A	B	$Y=\overline{A \cdot B}$
0	0	1
0	1	1
1	0	1
1	1	0

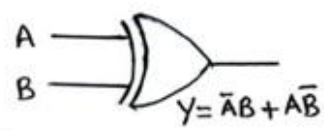
Ex-OR gate:

Pin Diagram

(f)



Symbol



Truth Table

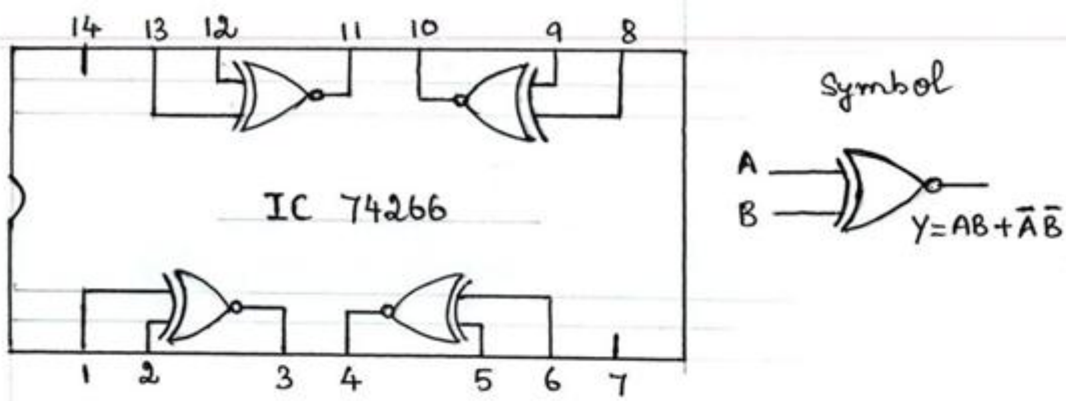
A	B	$Y=\bar{A}B+A\bar{B}$
0	0	0
0	1	1
1	0	1
1	1	0

Procedure:

1. The required IC's are placed on the bread board of the digital trainer kit.
2. Connections are given as per the logic diagram.
3. The IC's must be biased with +5V and gnd (connections are given to their respected pins alone).
4. The inputs for the gates are taken from the input terminals of the trainer kit.
5. Outputs are given to the LED arranged terminals.
6. The corresponding logic operations for all the cases are checked as per the truth table.

EX-NOR gate (g)

Pin Diagram



Truth Table

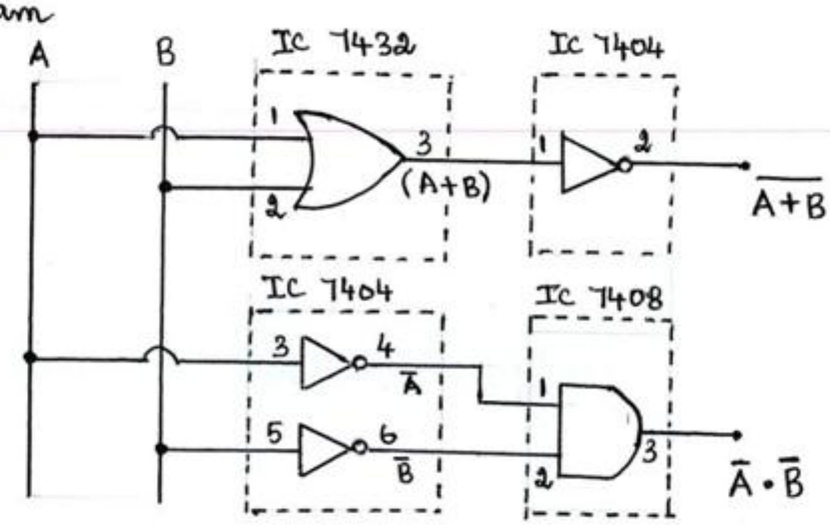
A	B	$Y = AB + \bar{A}\bar{B}$
0	0	1
0	1	0
1	0	0
1	1	1

Result:

Thus the logic operation of gates are studied and the truth table of OR, AND, NOT, NOR, NAND, EX-OR and EX-NOR gates & truth table for Flip Flop such as RS, D, JK and T are verified.

De Morgan's Theorem: a) $\overline{A+B} = \bar{A} \cdot \bar{B}$

Logic Diagram



Truth Table

A	B	$\bar{A}$	$\bar{B}$	A+B	$\overline{A+B}$	$\bar{A} \cdot \bar{B}$
0	0	1	1	0	1	1
0	1	1	0	1	0	0
1	0	0	1	1	0	0
1	1	0	0	1	0	0

b) VERIFICATION OF DE MORGAN'S THEOREM

Aim:

To verify De Morgan's Theorem using Logic gates.

Equipments / Components required:

Sl. No.	Name of the Equipment/Component	Range/Rating	Quantity
1	Digital Trainer Kit	---	1
2	IC 7408	5V-12V dc	1
3	IC 7432	5V-12V dc	1
4	IC 7404	5V-12V dc	1
5	Connecting wires (Single stand, G.I)	---	---

Theory:

De Morgan's Theorem:

Theorem 1: It says the complement of a sum equals the product of complements.

i.e. $A + B + C\ldots\ldots = A . B . C . \ldots\ldots$

Theorem 2: It says the complement of a product equals the sum of complements

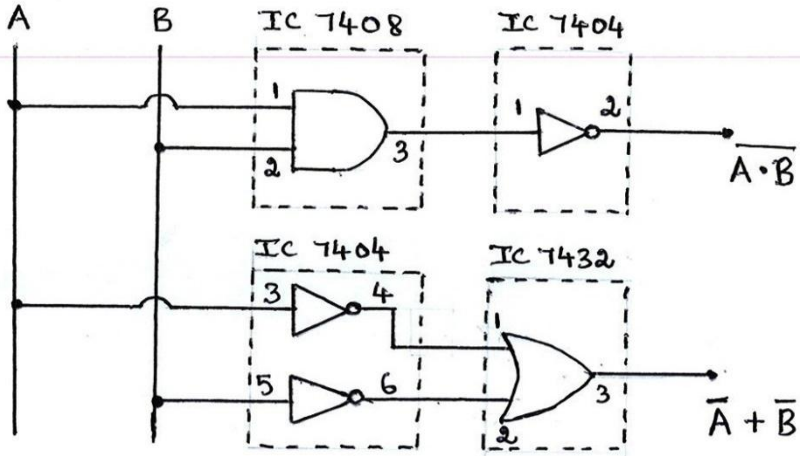
i.e. $A . B . C \ldots\ldots = A + B + C + \ldots\ldots$

Procedure:

1. The required IC's are collected and placed orderly on the bread broad of the digital trainer kit.
2. Initially, the IC's must be biased with +5V and gnd (connections are given to their respected pins alone).
3. Then, inputs are given to the gates from the input terminals provided in the trainer kit.
4. Outputs are given to the LED arranged terminals.
5. The corresponding logic operations for all the cases are checked as per the truth table.

b) $\overline{A \cdot B} = \bar{A} + \bar{B}$

Logic Diagram



Truth Table

A	B	$\bar{A}$	$\bar{B}$	$A \cdot B$	$\overline{A \cdot B}$	$\bar{A}+\bar{B}$
0	0	1	1	0	1	1
0	1	1	0	0	1	1
1	0	0	1	0	1	1
1	1	0	0	1	0	0

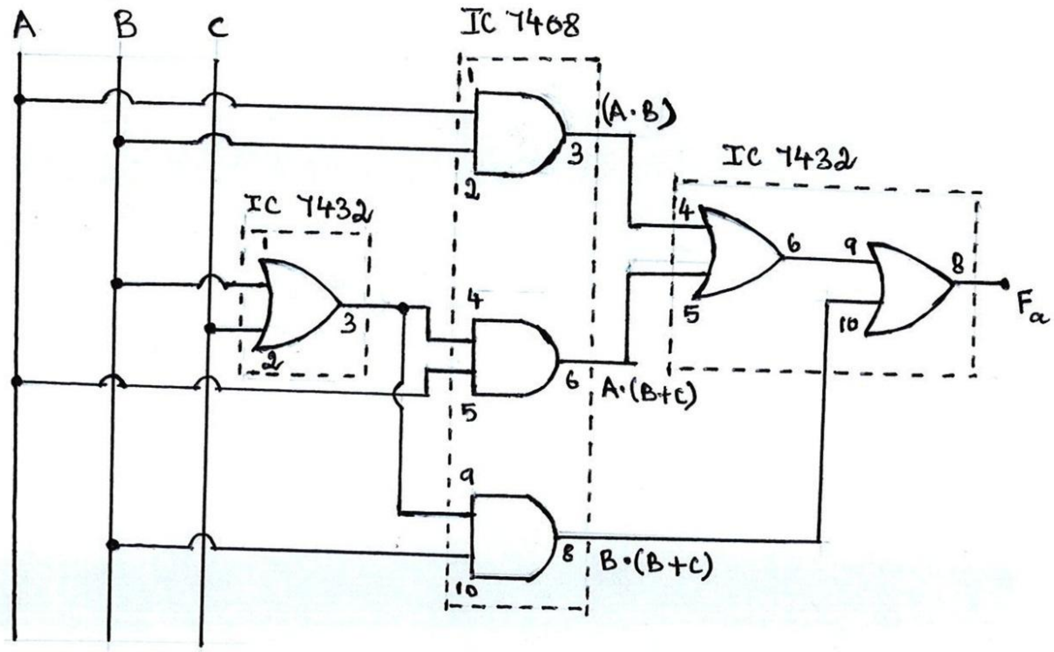
Result:

Thus the De Morgan's theorem using logic gates are verified.

a) Function as it is given:

$$F_a = (A \cdot B) + A \cdot (B+C) + B(B+C)$$

Logic Diagram:



Truth Table:

A	B	C	(A·B)	(B+C)	A·(B+C)	B·(B+C)	F_a
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0
0	1	0	0	1	0	1	1
0	1	1	0	1	0	1	1
1	0	0	0	0	0	0	0
1	0	1	0	1	1	0	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

c) IMPLEMENTATION OF DIGITAL FUNCTIONS USING LOGIC GATES AND UNIVERSAL GATES

Aim:

To realize the expression F= [(A .B) + A . (B+C) + A . (B+C)]

a) As it is given

b) After proper simplification using rules of Boolean algebra

Equipments / Components required:

Sl. No.	Name of the Equipment/Component	Range/Rating	Quantity
1	Digital Trainer Kit	---	1
2	IC 7408	5V-12V dc	1
3	IC 7432	5V-12V dc	1
4	Connecting wires (Single stand, G.I)	---	---

Theory:

Simplification by Algebraic Method:

The Boolean function can be transformed from an algebraic expression. There is only one that a Boolean function can be represented in a truth table. However, when the function is in algebraic form, it can be expressed in a variety of ways. The particular expressions used to designate the function will also dictate the interconnection of gates in the logic gates circuit diagram. By manipulating a Boolean expression according to Boolean algebra rules, it is sometimes possible to obtain a simpler expression for the same function and thus reduce the number of inputs to the gate.

Procedure:

1. The required IC's are collected and placed orderly on the bread broad of the digital trainer kit.
2. Connections are given as per the logic diagram.
3. The IC's must be biased with +5V and gnd (connections are given to their respected pins alone)
4. The inputs for the gates are taken from the input terminals of the trainer kit.
5. Outputs are given to the LED arranged terminals.
6. The corresponding logic operations for all the cases are checked as per the truth table.

b) After proper simplification using rules of Boolean algebra:

$$F_b = (A \cdot B) + A \cdot (B + C) + B \cdot (B + C)$$

$$= (A \cdot B) + [(A \cdot B) + (A \cdot C)] + [(B \cdot B) + (B \cdot C)]$$

⇒ By distributive law $[A \cdot (B + C)] = (A \cdot B) + (A \cdot C)$

$$= (A \cdot B) + (A \cdot C) + (B \cdot B) + (B \cdot C)$$ ⇒ $(A + A) = A$

$$= (A \cdot B) + (A \cdot C) + B + (B \cdot C)$$ ⇒ $(A \cdot A) = A$

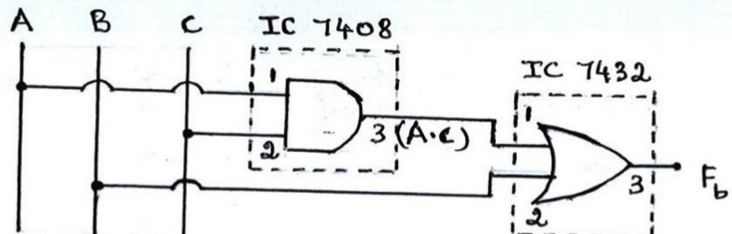
$$= (A \cdot B) + (A \cdot C) + B \cdot (1 + B)$$ ⇒ $(1 + B) = 1$

$$= (A \cdot B) + (A \cdot C) + B$$

$$= B \cdot (A + 1) + (A \cdot C)$$ ⇒ By distributive law

$$\boxed{F_b = B + (A \cdot C)}$$ ⇒ $(A + 1) = 1$

Logic Diagram:



Truth Table:

A	B	C	(A·C)	$F_b = B + (A \cdot C)$
0	0	0	0	0
0	0	1	0	0
0	1	0	0	1
0	1	1	0	1
1	0	0	0	0
1	0	1	1	1
1	1	0	0	1
1	1	1	1	1

Result:

The given expression is realized as it is and after simplification by verifying the truth table.