## CONTENTS

# GENERAL INSTRUCTIONS

## 1) While Doing Connections and Taking Readings: -

a. Wires used for doing connections should be capable of carrying current through them. At the same time, they should not be too heavy to cause burden for the terminal pin connectors. Please note that the terminals given for PC are weaker than that of CC (especially in high current range wattmeter's). So- if you connect thick wire to the PC terminals, you are burdening the PC terminals. Also note that using too heavy wire than the required is uneconomic.

b. Use flexible (thin) wires to connect voltmeter and PC of wattmeter's. Because they carry very small currents. This will ease to do connections as well as not harm the terminals of the meters.

c. Best method of doing connections: - First do loop connections, that is connect those wires which act as links between supply and load. Then insert (= connect) PC circuit of wattmeter and voltmeter wherever necessary. This will help you in easy understanding, analyzing and troubleshooting the circuit

d. Fix wires with optimum tightness. Do not leave the wires loose which may cause risk of electric shock for the operator or damage to the equipment and supply. Similarly, do not over tight the terminals/screws. This will damage the terminals and make them useless for future.

e. Ammeter and CC of wattmeter have less number of turns and low resistance, because they are connected in series with the load. They carry load current. Since sufficient or considerable amount of current flows in these coils, few turns are enough to provide desired deflection torque for the movement of the pointer.

f. Voltmeter and PC circuit of wattmeter are connected in parallel with the load or supply. Hence they are made of high resistance (else they will consume large power!). To make the circuit highly resistive, a series resistance is added with their coils. Now, since current through the coil is very small (due to insertion of this series resistance), they need large number of turns to produce the desired deflection torque for the movement of the pointer. Hence voltmeter and PC of wattmeter have large number of turns when compared to those of an ammeter or CC of wattmeter.

g. So- coil of an ammeter and CC of a wattmeter will have low resistance (ideally zero). Similarly coil of a voltmeter and PC of a wattmeter will have high resistance (ideally infinity).

h. Note down zero error if any in the instrument and take it into account. Also avoid parallax error while taking reading.

i. Check for loose connections wherever possible, especially in the rheostat. Do not forget to check leads of multimeter and also the wires for continuity while trouble shooting.

j. Choosing rheostat: - In general, the value of the rheostat should be at least equal to the value of the resistance of the circuit, preferably 4 to 6 times higher. The rheostat should be able to carry currents safely without overheating.

k. While connecting the switch, the fuse should be towards load side so that when switch is opened, the fuse can be safely touched (during trouble shooting to verify) and replaced when needed.

l. For Ammeter and Voltmeters- In AC circuits, MI instruments should be used; In DC circuits, either MI or MC can be used, but MC are preferred in DC circuits due to its higher accuracy.

m. For Wattmeter: - Dynamometer Type WM is used in both AC or DC circuits.

**2)Handle Instruments Carefully.** Do not touch the mirror of an instrument or screen of a CRO or even the computer. This will make it dirty and difficult to read them in future.

**3)Selecting Range of a Meter: -**

a) It is better to have the range a little bit higher (say 10 to 20%) than the maximum value that is going to be measured. This will avoid risk of taking damage to the meter. Also the range should not be too high than the maximum value to be measured, because in that case, effect of errors will be more since the reading is just a small percentage of the full scale reading. Also there can be loss of accuracy due to loss of resolution.

**4)Note down the name plate details** of any equipment or instrument. This habit will be of great help in future.

**5)While writing the record book: -**

- Title, Aim, Apparatus, Procedure (including precautions if any), and Results should be written on the front side of a page.
- Circuit Diagram, Tabular Column, Formulae used, Observations and Calculations, Specimen graph (nature of graph) should be written on the back side of a page.
- Do not forget to mention/write units of a quantity measured or calculated. Also double underline the final answer.

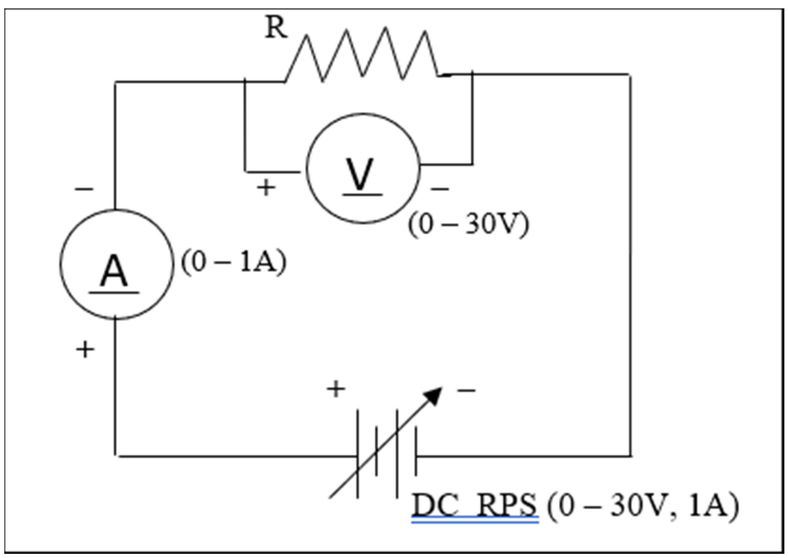
# Ex. 01 Connect Voltmeter and Ammeter in a Simple Circuit

**Aim:** To measure voltage and current across a resistance in an electrical circuit.

**Materials required:**

| Sl.no | Materials | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter | 0-100mA | 01 |
| 2 | Voltmeter | 0-10 V | 01 |
| 3 | RPS | 0-30V | 01 |
| 4 | Wire wound resistor or any suitable value carbon resistor | say 1000 Ω | 01 |
| 5 | Connecting wires. | | |

**Circuit Diagram:**




**Procedure:**

1. Connections are made as per the circuit diagram.
2. Switch ON the power supply.
3. Vary applied voltage in steps of 2V and at each step note down the ammeter and voltmeter readings in the tabular column.
4. Switch OFF the power supply and mains.
5. Calculate the resistance value in each case using the relation R = $\frac{V}{I}$ Ω.

**Tabular column:**

| Sl No. | Applied Voltage (volts) | Voltage across R V(volts) | Current through R I(mA) | R=V/I (Ω) |
|---|---|---|---|---|
| 1 | 2 | | | |
| 2 | 4 | | | |
| 3 | 6 | | | |
| 4 | 8 | | | |
| 5 | 10 | | | |

**Calculations:**

**Average value of resistance, R = Ω**

**Result: The value of R obtained from the experiment is justified.**

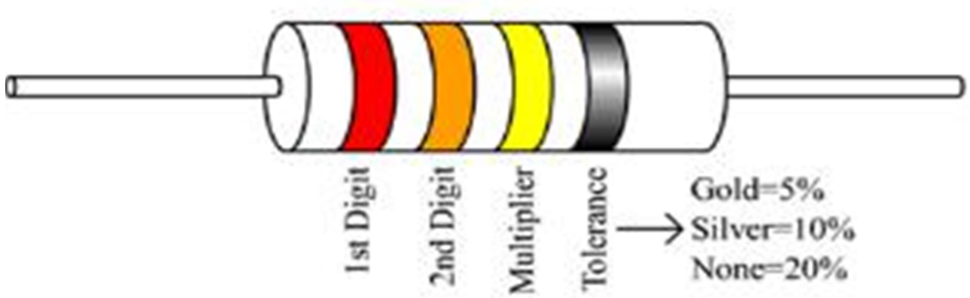
# Ex. 02 Determination of the value of resistance

**Aim:** Determine the value of resistance by colour code and compare it with multimeter readings.

**Materials required:**

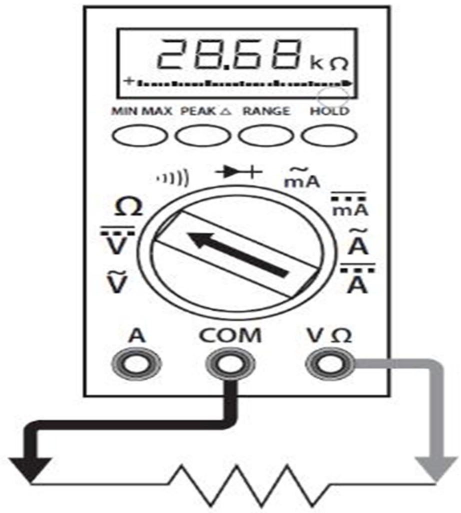
| Sl.no | Materials | Range | Quantity |
|---|---|---|---|
| 1 | Unknown Resistors | | 03 |
| 2 | Colour code chart | | 01 |
| 3 | Digital multimeter | | 01 |

**Colour Code chart:**




| Color | Digit | Multiplier | Tolerance (%) |
|---|---|---|---|
| Black | 0 | $10^0$ (1) | |
| Brown | 1 | $10^1$ | 1 |
| Red | 2 | $10^2$ | 2 |
| Orange | 3 | $10^3$ | |
| Yellow | 4 | $10^4$ | |
| Green | 5 | $10^5$ | 0.5 |
| Blue | 6 | $10^6$ | 0.25 |
| Violet | 7 | $10^7$ | 0.1 |
| Grey | 8 | $10^8$ | |
| White | 9 | $10^9$ | |
| Gold | | $10^{-1}$ | 5 |
| Silver | | $10^{-2}$ | 10 |
| (none) | | | 20 |

**Multimeter connection:**




**Procedure:**

1. Using the colour code chart determine the theoretical values of each of the given resistors along with the tolerance.
2. Turn the meter ON and press Ω for Resistance Measurement
3. Plug the black test lead into the common input jack (COM). Plug the red lead into the resistance input jack(VΩ).
4. Select the resistance setting.
5. Touch the probe tips across the component or portion of the circuit.
6. View the reading and note the value in the observation table.
7. Compare the readings with theoretical values.

**Tabular column:**

| Sl. No. | Theoretical values of resistor calculated using colour code | Measured values of resistor measured using multimeter |
|---|---|---|
| | | |
| | | |

**Result:** The theoretical value of resistance calculated using colour code is compared with measured value using multimeter.

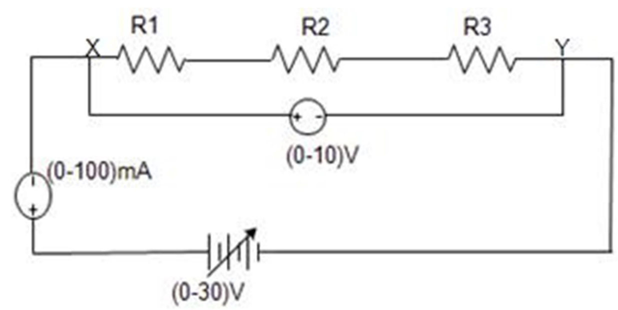
# Ex. 03 Determine the equivalent resistance of series connected resistances

**Aim:** To determine the equivalent resistance of series connected resistances.

**Materials Required:**

| Sl.no | Materials | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter | 0-100mA | 01 |
| 2 | Voltmeter | 0-10 V | 01 |
| 3 | RPS | 0-30V | 01 |
| 4 | Resistors | Of different values | 03 |
| 5 | Connecting wires. | | |

**Circuit diagram:**




**Procedure:**

1. Determine the value of each resistor using colour code or multimeter and enter in Table-1.
2. Connect the circuit as shown in the circuit diagram.
3. Switch on the RPS and set the voltage to 5V.
4. Record the ammeter reading and the voltmeter reading in the Table -2 and determine the equivalent resistance.
5. Compare this value with equivalent resistance determined theoretically.
6. Reduce the voltage and switch off the supply.

**Table -1**

| Resistor value | Measured using multimeter in kΩ |
|---|---|
| $\boldsymbol{R_1}$ | |
| $\boldsymbol{R_2}$ | |
| $\boldsymbol{R_3}$ | |

**Table-2**

| Resistor used | Voltage(V) in volts | Current(I) in mA | $R_{eq} = \frac{V}{I}$ kΩ |
|---|---|---|---|
| $\boldsymbol{R_1, R_2, R_3}$ **in series** | | | |

(1) Equivalent resistance calculated theoretically from Table -1 = $R_{eq} = R_1 + R_2 + R_3 =$ ------ kΩ

(2) Equivalent resistance determined experimentally from table -2 = $R_{eq} =$ --------- kΩ

**Results:** There is close agreement between the equivalent resistance calculated theoretically and determined experimentally. Hence, $R_{eq}$ = R1 +R2 +R3 is verified.

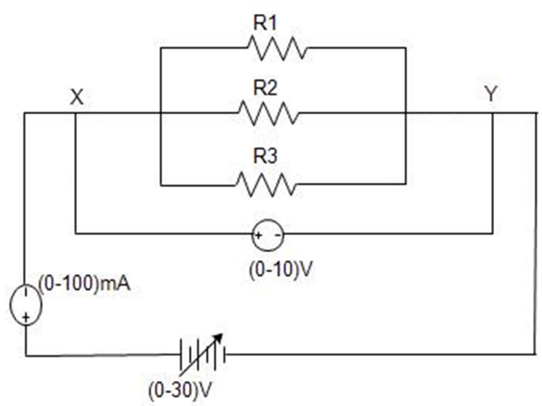
# Ex. 04 Determine the equivalent resistance of parallel connected resistances

**Aim:** Determine the equivalent resistance of parallel connected resistances.

**Materials Required:**

| Sl.no | Materials | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter | 0-100mA | 01 |
| 2 | Voltmeter | 0-10 V | 01 |
| 3 | RPS | 0-30V | 01 |
| 4 | Resistors | Of different values | 03 |
| 5 | Connecting wires | | |

**Circuit diagram:**




**Procedure:**

1. Determine the value of each resistor using colour code or multimeter and enter in Table-1.
2. Connect the circuit as shown in the circuit diagram.
3. Switch on the RPS and set the voltage to 5V.
4. Record the ammeter reading and the voltmeter reading in the Table -2 and determine the equivalent resistance.
5. Compare this value with equivalent resistance determined theoretically.
6. Reduce the voltage and switch off the supply.

**Table -1**

| Resistor value | Measured using multimeter in kΩ |
|---|---|
| $R_1$ | |
| $R_2$ | |
| $R_3$ | |

**Table-2**

| Resistor used | Voltage(V) in volts | Current(I) in mA | $R_{eq} = \frac{V}{I}$ kΩ |
|---|---|---|---|
| $R_1, R_2, R_3$ **in parallel** | | | |

(1) Equivalent resistance calculated theoretically from table -1 $= \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} =$ **---kΩ**

Therefore, $R_{eq}$= --------- kΩ

(2) Equivalent resistance determined experimentally from table-2 $R_{eq} =$ **---------** kΩ

**Results:** There is close agreement between the equivalent resistance calculated theoretically and determined experimentally. Hence, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$___is verified.

# Ex. 05 Demonstrate effects of shorts and opens in a circuit

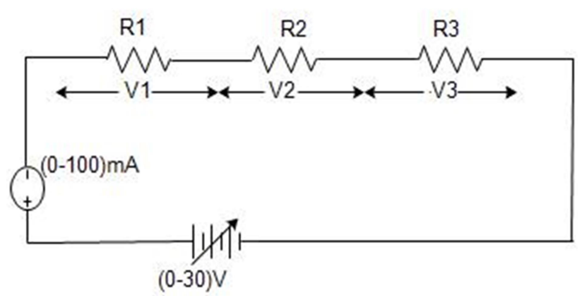
**Aim:** To demonstrate the effects of short circuit and open circuit in a series circuit.

**Materials required:**

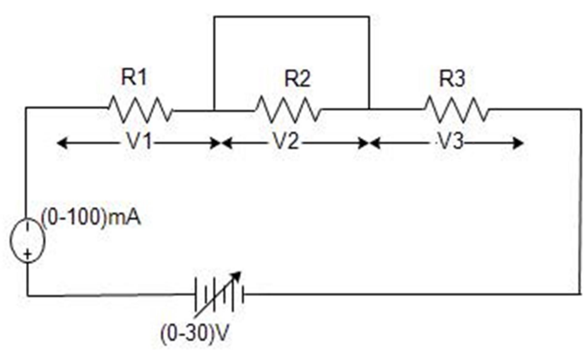
| Sl.no | Materials | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter | 0-100mA | 01 |
| 2 | Voltmeter | 0-10 V | 01 |
| 3 | RPS | 0-30V | 01 |
| 4 | Resistors | Of different values | 03 |
| 5 | Connecting wires. | | |

**Circuit diagram:**

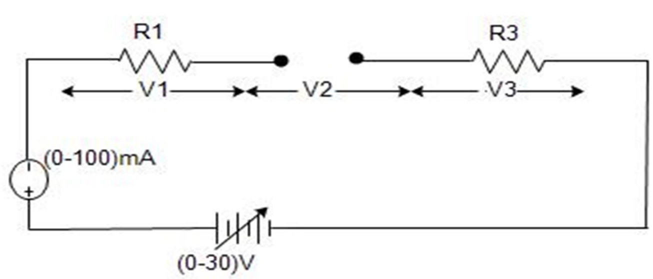
**1.Simple series circuit:**




**2.Shorted component in a series circuit:**




**3.Opened components in a series circuit**



**Procedure:**

1. Rig up the circuit as shown in fig.1.
2. Set the RPS voltage to 10V
3. Measure the current and voltages V1, V2 and V3.
4. Turn off the supply.
5. Rig up the circuit as shown in fig.2. to create a short-circuited series circuit.
6. Set the RPS voltage to 10V.
7. Measure the current and voltages V1, V2 and V3.
8. Turn off the supply.
9. Rig up the circuit as shown in fig.3. to create an open circuited series circuit.
10. Set the RPS voltage to 10V
11. Measure the current and voltages V1, V2 and V3.
12. Turn off the supply.

**Observations:**

| Sl No | Circuit conditions | Applied voltage | Measured total current | Voltage drop V1 | Voltage drop V2 | Voltage drop V3 |
|---|---|---|---|---|---|---|
| 1 | Normal series | | | | | |
| 2 | Series Short circuit | | | | | |
| 3 | Series Open circuit | | | | | |

**Result:** The effects of short circuit and open circuit in a series circuit are analysed and the numerical results are tabulated.

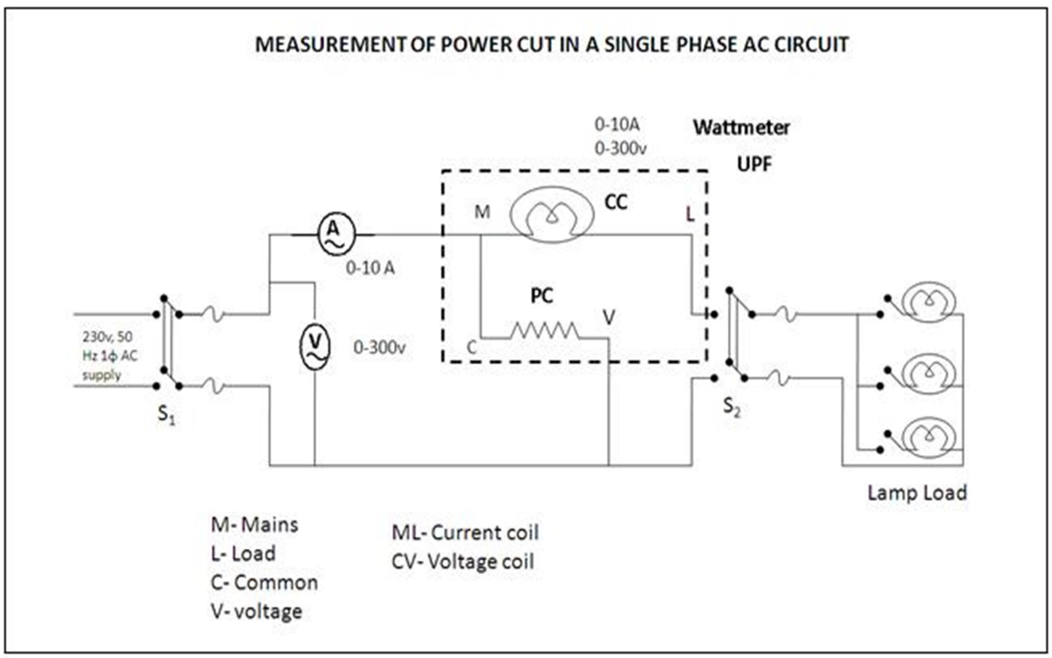
# Ex. 06 Measurement of the voltage, current, power using relevant measuring instruments in a single-phase load.

**Aim:** To measure the voltage, current, power using relevant measuring instruments in a single-phase load.

**Materials required:**

| Sl.No | Apparatus | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter MI | 0-10A | 01 |
| 2 | Voltmeter MI | 0-300V | 01 |
| 3 | Wattmeter | 0-300V,10A,UPF | 01 |
| 4 | Single phase Lamp Load | - | 01 |
| 5 | Connecting wires. | - | As per requirements |

**Circuit Diagram:**




**Procedure:**

1. Connections are made as per the circuit diagram.
2. Ensure that all the meter readings are at zero position.
3. Keeping the load switch $S_2$ open, close the supply switch $S_1$.
4. Apply load in steps of 1 ampere and at each step note down ammeter, voltmeter and wattmeter readings in the tabular column.
5. Take 4 to 5 readings. Then reduce the load to zero and open the load switch, $S_2$.Then open the supply switch $S_1$.

6. Calculate the value of power using the formulae:
   Power = $W \times W_C$ Watts

Where, Wattmeter constant,

$$W_C = \left(\frac{\text{VIcos}\emptyset}{\text{Full scale reading of the wattmeter}}\right)$$

**Tabular column and Calculations:**

| SL NO | V<br>Volt | I<br>Amp | W<br>Watt | Power<br>WxWc Watt |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |

**Result:** The voltage, current, power are measured for a single phase load using relevant measuring instruments.

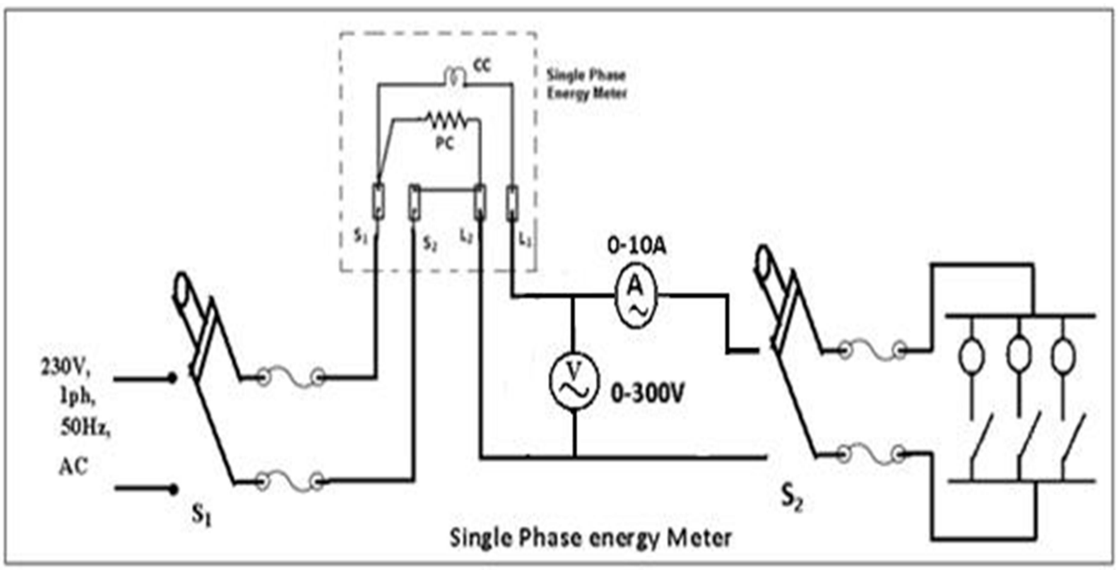
## Ex. 07 Measurement of single phase energy using relevant measuring instruments in a Single-phase load.

**Aim: -** To measure energy(kWh) in single phase AC system using singe phase Energy Meter for the given lamp load**.**

**Materials required:**

| Sl. No | Apparatus | Range | Quantity |
|---|---|---|---|
| 1 | Ammeter MI | 0-10A | 01 |
| 2 | Voltmeter MI | 0-300V | 01 |
| 3 | Single phase energy meter | | 01 |
| 4 | Single phase Lamp Load | - | 01 |
| 5 | DPST Switch | | 02 |
| 6 | Stop watch | | 01 |
| 7 | Connecting wires. | - | As per requirements |

**Circuit Diagram:**




**Procedure: -**

1. Connections are made as per the circuit diagram.
2. Ensure that all the meter readings are at zero position.
3. Keeping the load switch $S_2$ open, close the supply switch S1.
4. Apply load in steps of 1 ampere and note down the time taken for 3 revolutions on the energy meter using stop clock. Also, note down the ammeter and voltmeter readings in the tabular column.

5. Repeat the same step by increasing the load in steps of 1 amps and at each step note down the ammeter, voltmeter readings and also the time taken for 3 revolutions.

6. Take 4 to 5 readings. Then reduce the load to zero and open the load switch, $S_2$.Then open the supply switch $S_1$.

7. Tabulate the readings, note down the value of Energy Meter Constant K (marked on the meter).
8. Calculate the value of energy consumed using the formula:

$$E = \frac{\text{No. of revolutions}}{(\text{Energy meter constant})} = \left(\frac{N}{K}\right) \text{kWh}$$

**Tabular column and Calculations:**

**Energy Meter Constant (K) in Rev/kWh =**

| Sl no. | Voltage(V) volts | Load current(I) amps | No. of revolutions(N) | Time taken(t) in seconds. | Energy consumed = $\left(\frac{N}{K}\right)$kWh |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Result:**

The energy measurement for various load values for a single phase AC circuit are done experimentally.

## EX. 08 - Wire up and test PVC Conduit wiring to control one lamp from one place

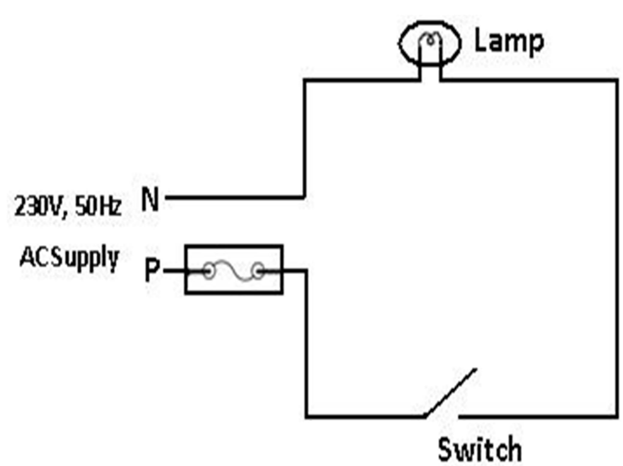
**AIM:** To wire up and test PVC Conduit wiring to control one lamp from one place

**Materials required:**

| Sl.no | Components | Specification | Quantity |
|---|---|---|---|
| 1. | Gang box | 1-way, plastic | 1 No. |
| 2. | Switch | 5A, SP, flush type | 1 No. |
| 3. | Round block | Plastic | 1 No. |
| 4. | Fuse unit/MCB | 5A, SP | 1 No. |
| 5. | Lamp holder | Straight or Angle Batten type | 1 No. |
| 6. | Bulb | 60 W | 1 No. |
| 7. | Conduit pipe | ¾" P.V.C | LS |
| 8. | T joint/Junction box | ¾" P.V.C / ¾" PVC 3-way | 1 No. |
| 9. | saddles | Iron | LS |
| 10. | screws | Iron | LS |
| 11. | Wires | 1 $mm^2$ Copper | LS |

**Tools used:** Hacksaw blade, Poker, Hammer, Screw driver, Cutting pliers, Wire stripper, Tester.

**Circuit diagram:**



**Wiring diagram:**

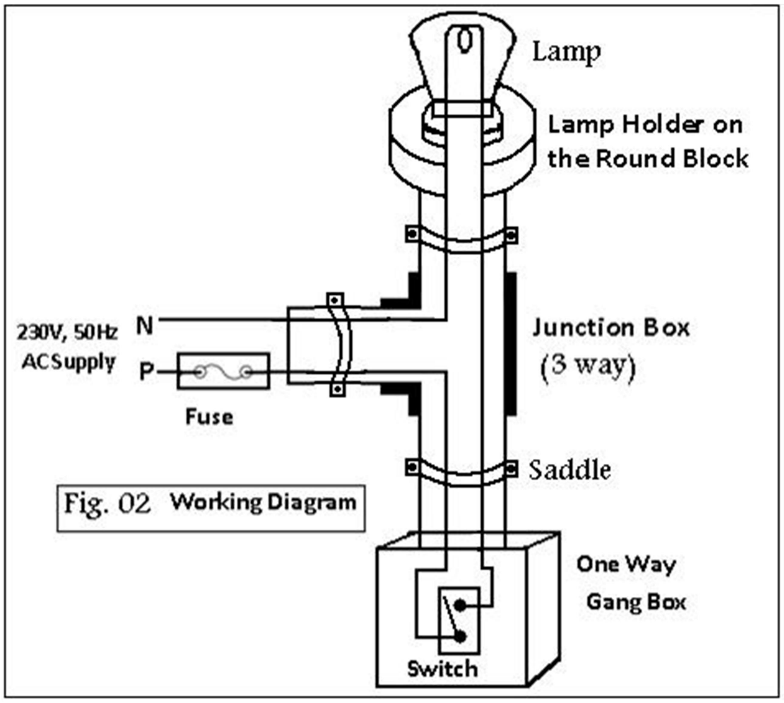


Fig. 02 Working Diagram

**Procedure:**

1. Mark the lines on the wooden board as per the working diagram.
2. Cut the PVC pipes to the required length.
3. Fix the PVC pipes on the marked line with their fixtures like: junction box, saddles, round block etc.
4. Draw the wires through pipes.
5. Fix the switches and fuse unit to the gang boxes after making proper connections.
6. Connect the wiring circuit to the 230V, 50Hz, 1∅ AC supply.
7. Verify the results as per the tabular column.

**Tabular column:**

| Switch Condition | Lamp Condition |
|---|---|
| OFF | OFF |
| ON | ON |

**Result:** The PVC conduit wiring is wired up and tested to control one lamp from one place.

# Ex. 09 Wire Up and Test PVC Conduit Wiring to Control a Lamp and A Three Pin Socket

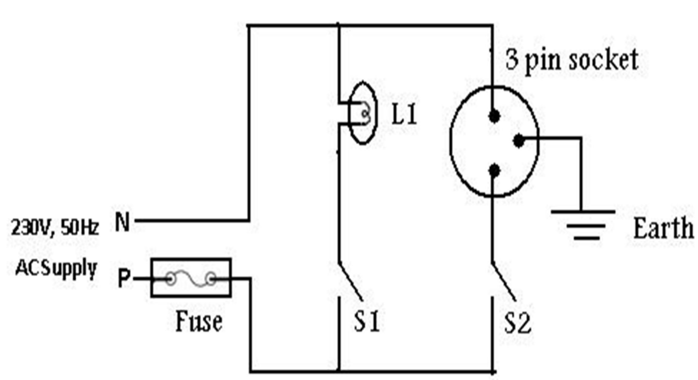
**AIM:** To wire up and test PVC Conduit wiring to control a lamp and a three pin socket.

**Materials required:**

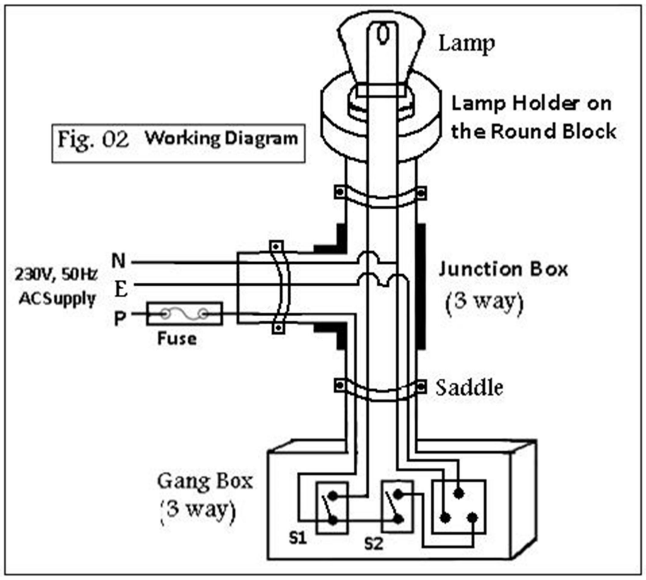
| Sl.no | Components | Specification | Quantity |
|---|---|---|---|
| 1. | Gang box | 3-way Domestic, plastic | 1 No. |
| 2. | Switch | 5A, SP, flush type | 2 Nos. |
| 3. | Socket | 3 pin 5A, 2 in 1 | 1 No. |
| 4. | Round block | plastic | 1 No. |
| 5. | Lamp holder | Straight or Angle Batten type | 1 No. |
| 6. | Bulb | 60 W | 1 No. |
| 7. | Fuse unit/MCB | 5A, SP | 1 No. |
| 8. | Conduit pipe | ¾" P.V.C | LS |
| 9. | Tee | ¾" P.V.C | 1 No. |
| 10. | Saddles | Iron | LS |
| 11. | Screws | Iron | LS |
| 12. | Wires | 1 $mm^2$ Copper | LS |

**Tools used:** Hacksaw blade, Poker, Hammer, Screw driver, Cutting pliers, Wire stripper, Tester

**Circuit diagram:**



**Wiring diagram:**




**Tabular column:**

| Switch Condition | | Lamp Condition | Socket Condition |
|---|---|---|---|
| S1 | S2 | B | S |
| OFF | OFF | OFF | OFF |
| ON | OFF | ON | OFF |
| OFF | ON | OFF | ON |
| ON | ON | ON | ON |

**Procedure:**

1. Mark the lines on the wooden board as per the working diagram.
2. Cut the PVC pipes to the required length.
3. Fix the PVC pipes on the marked line with their fixtures like: junction box, saddles, round block etc.
4. Draw the wires through pipes.
5. Fix the switches and fuse unit to the gang boxes after making proper connections.
6. Connect the wiring circuit to the 230V, 50Hz, 1Ø AC supply.
7. Verify the results as per the tabular column.

**Result:** The PVC conduit wiring is wired up and tested to control one lamp and one socket.

# Ex. 10 Wire Up and Test PVC Conduit Wiring to Control Two Lamps and two Three Pin Socket

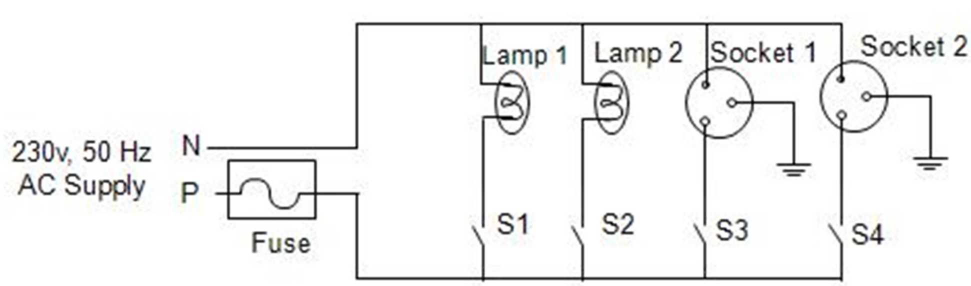
**AIM:** To wire up and test PVC Conduit wiring to control a lamp and a three pin socket.

**Materials required:**

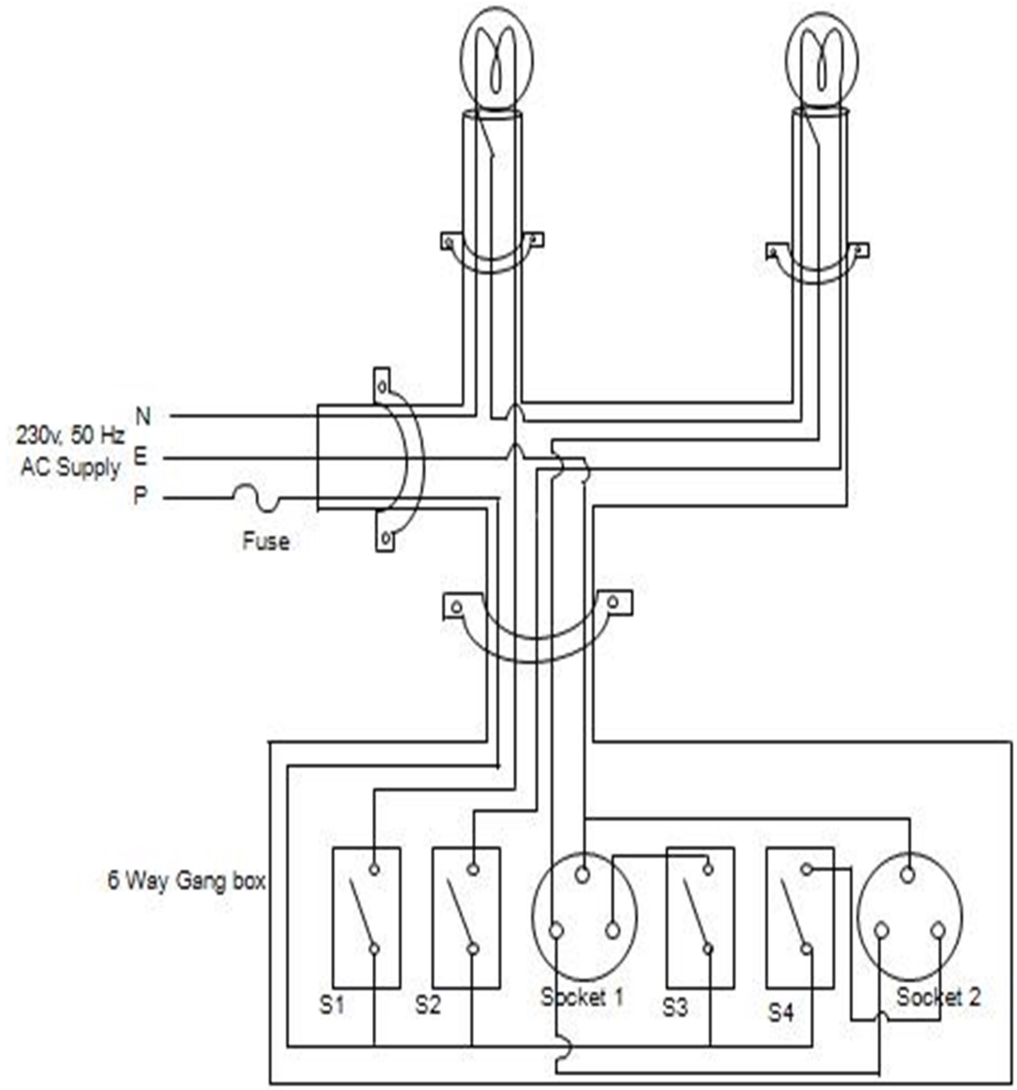
| Sl.no | Components | Specification | Quantity |
|---|---|---|---|
| 13. | Gang box | 3-way Domestic, plastic | 1 No. |
| 14. | Switch | 5A, SP, flush type | 2 Nos. |
| 15. | Socket | 3 pin 5A, 2 in 1 | 1 No. |
| 16. | Round block | plastic | 1 No. |
| 17. | Lamp holder | Straight or Angle Batten type | 1 No. |
| 18. | Bulb | 60 W | 1 No. |
| 19. | Fuse unit/MCB | 5A, SP | 1 No. |
| 20. | Conduit pipe | ¾" P.V.C | LS |
| 21. | Tee | ¾" P.V.C | 1 No. |
| 22. | Saddles | Iron | LS |
| 23. | Screws | Iron | LS |
| 24. | Wires | 1 $mm^2$ Copper | LS |

**Tools used:** Hacksaw blade, Poker, Hammer, Screw driver, Cutting pliers, Wire stripper, Tester.

**Circuit diagram:**



**Wiring diagram:**




**Procedure:**

1. Mark the lines on the wooden board as per the working diagram.
2. Cut the PVC pipes to the required length.
3. Fix the PVC pipes on the marked line with their fixtures like: junction box, saddles, round block etc.
4. Draw the wires through pipes.
5. Fix the switches and fuse unit to the gang boxes after making proper connections.
6. Connect the wiring circuit to the 230V, 50Hz, 1Ø AC supply.
7. Verify the results as per the tabular column.

**Tabular column:**

| Switch Condition | | | | Lamp Condition | | Socket Condition | |
|---|---|---|---|---|---|---|---|
| S1 | S2 | S3 | S4 | Lamp1 | Lamp2 | Socket1 | Socket2 |
| OFF | OFF | OFF | OFF | OFF | OFF | OFF | OFF |
| ON | OFF | OFF | OFF | ON | OFF | OFF | OFF |
| OFF | ON | OFF | OFF | OFF | ON | OFF | OFF |
| OFF | OFF | ON | OFF | OFF | OFF | ON | OFF |
| OFF | OFF | OFF | ON | OFF | OFF | OFF | ON |

**Result:** The PVC conduit wiring is wired up and tested to control two lamps and two sockets.

## Ex. 11 Wire Up and test PVC conduit wiring to control one lamp from two different places using suitable protective devices.

**AIM:** To wire up and test PVC conduit wiring to control one lamp from two different places using suitable protective devices.

**Materials required:**

| Sl no. | Components | Specifications | Quantity |
|---|---|---|---|
| 1. | Gang box | 1-way, plastic | 2 Nos. |
| 2. | 2-way Switch | 5A, flush type | 2 Nos. |
| 3. | Round block | plastic | 1 No. |
| 4. | Lamp holder | Straight or Angle Batten type | 1 No. |
| 5. | Bulb | 60 W | 1 No. |
| 6. | Fuse unit/MCB | 5A, SP | 1 No. |
| 7. | Conduit pipe | ¾" P.V.C | LS |
| 8. | Tee | ¾" P.V.C | 2 Nos. |
| 9. | Elbow/Bend | ¾" P.V.C | 1 No. |
| 10. | Saddles | Iron | LS |
| 11. | Screws | Iron | LS |
| 12. | Wires | 1 $mm^2$ Copper | LS |

**Tools used:** Hacksaw blade, Poker, Hammer, Screw driver, Cutting pliers, Wire stripper, Tester

**Circuit diagram:**

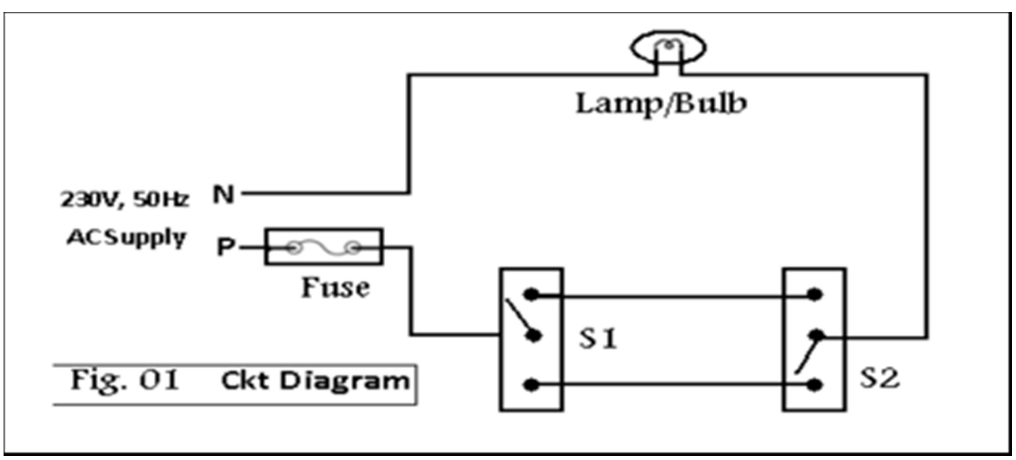
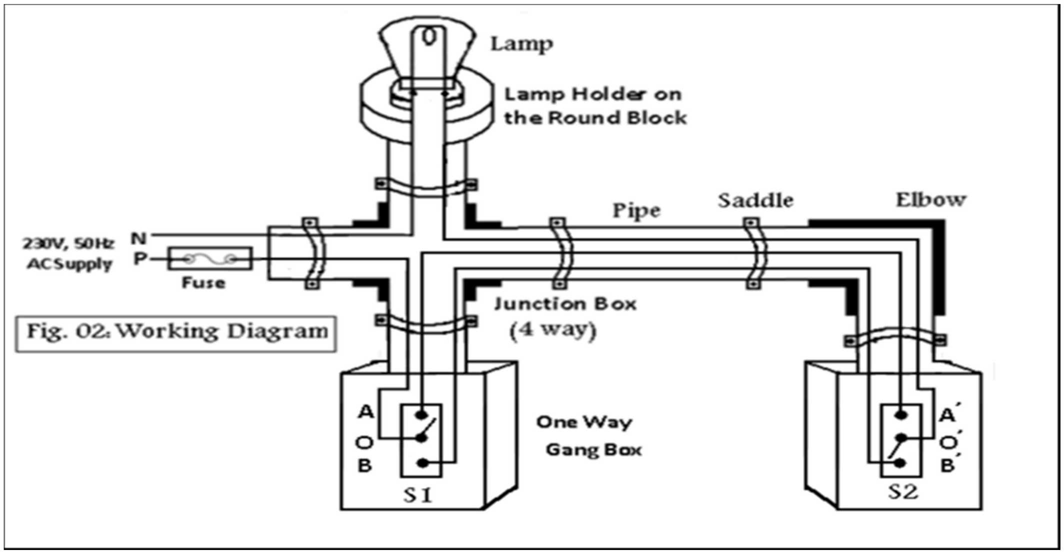



Fig. 01 Ckt Diagram

**Working diagram:**




**Procedure:**

1. Mark the lines on the wooden board as per the working diagram.
2. Cut the PVC pipes to the required length.
3. Fix the PVC pipes on the marked line with their fixtures like: junction box, saddles, round block etc.
4. Draw the wires through pipes.
5. Fix the switches and fuse unit to the gang boxes after making proper connections.
6. Connect the wiring circuit to the 230V, 50Hz, 1∅ AC supply.
7. Verify the results as per the tabular column.

**Tabular column:**

| Switch Condition | | Lamp Condition |
|---|---|---|
| S1 | S2 | B |
| A | A | ON |
| A | B | OFF |
| B | A | OFF |
| B | B | ON |

**Result:** The PVC conduit wiring is wired up and tested to control one lamp from two different places using suitable protective devices.

## Ex. 12 Test IC's 7408 and 7400 and Verify the truth-table for AND & NAND logic gates.

**AIM:** To test IC's 7408 and 7400 and Verify the truth-table for AND and NAND logic gates.

**Materials required:**

| Sl.No | Apparatus | Quantity |
|---|---|---|
| **1** | Digital IC Trainer | 01 |
| **2** | AND Gate IC 7408 | 01 |
| **3** | NAND Gate IC 7400 | 01 |
| **4** | Patch cords | As per requirements |

**Circuit diagram:**

**AND gate (7408):**

**Fig.1 Pin Diagram**

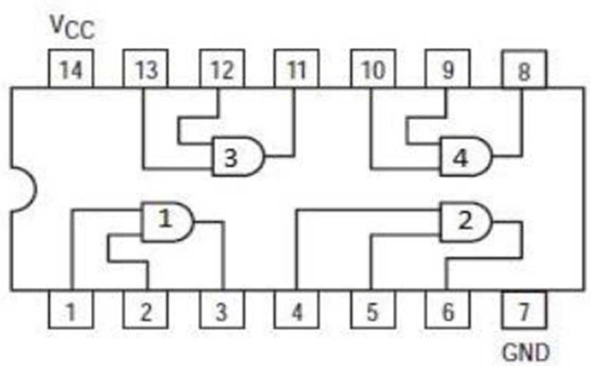
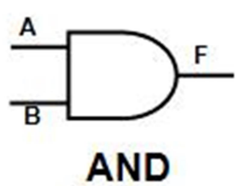



**Fig.2 Logic Symbol**




**Truth table:**

| Inputs | | Output |
|---|---|---|
| A | B | F |
| 0 | 0 | 0 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 1 |

**NAND gate (7400):**

**Fig.1 Pin Diagram**

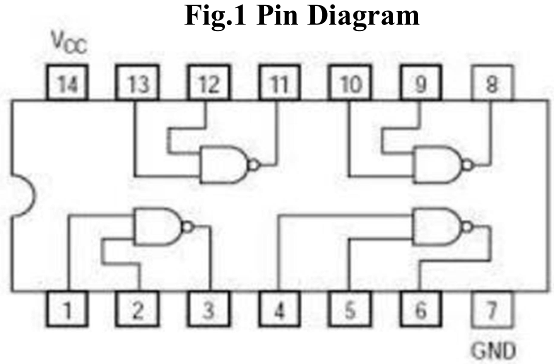
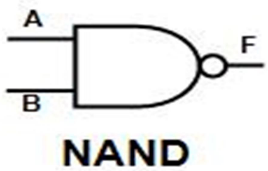


**Fig.2 Logic Symbol:** **Truth table:**




| Inputs | | Output |
|---|---|---|
| A | B | F |
| 0 | 0 | 1 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 0 |

**Procedure: -**

1. The ICs are tested for their correctness using IC tester.
2. Mount the ICs on the IC base properly provided on the trainer kit.
3. Connect pin no. 7 to ground and pin no. 14 to $+V_{CC}$.
4. Then connect the input pins to inputs switches and output pins to output LED's.
5. Switch ON the supply to the trainer kit.
6. Apply the possible combination of inputs and observe the outputs.
7. Repeat the above procedure to verify the truth tables of AND and NAND gates.
8. Then switch OFF the supply.

**Observations:**

**Table 01:- Truth Table of AND Gate**

| INPUTs | | Theoretical OUTPUT | Output observed |
|---|---|---|---|
| A | B | Y = A.B | $Y_1$ = A.B |
| 0 | 0 | 0 | |
| 0 | 1 | 0 | |
| 1 | 0 | 0 | |
| 1 | 1 | 1 | |

**Table 02:- Truth Table of NAND Gate**

| INPUTs | | Theoretical OUTPUT | Output observed |
|---|---|---|---|
| A | B | $Y = \overline{A.B}$ | $Y_1 = \overline{A.B}$ |
| 0 | 0 | 1 | |
| 0 | 1 | 1 | |
| 1 | 0 | 1 | |
| 1 | 1 | 0 | |

**Result:** IC's 7408 and 7400 are tested and the truth-table for AND and NAND logic gates are verified.

## Ex. 13 Test IC’s 7432 And 7402 And Verify the Truth-Table for OR and NOR Logic Gates.

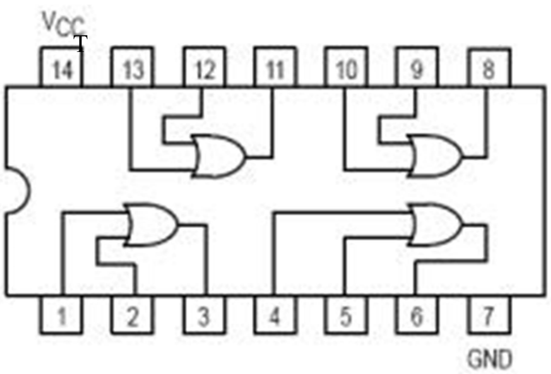
**AIM:** To test IC’s 7432 and 7402 and Verify the truth-table for OR and NOR logic gates.

**Materials required:**

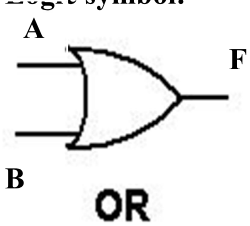
| Sl.No | Apparatus | Quantity |
|---|---|---|
| 1 | Digital IC Trainer | 01 |
| 2 | OR Gate IC 7432 | 01 |
| 3 | NOR Gate IC 7402 | 01 |
| 4 | Patch cords | As per requirements |

**OR gate (IC 7432):**

**Pin diagram:**




**Logic symbol:**

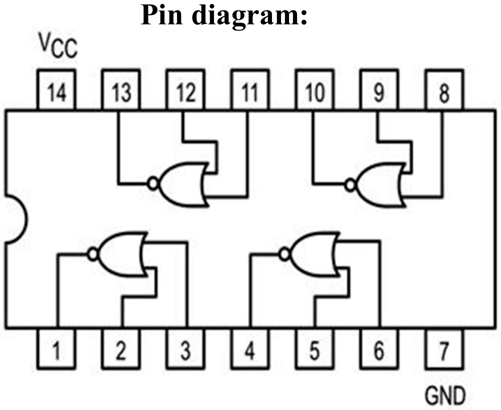



**Truth table:**

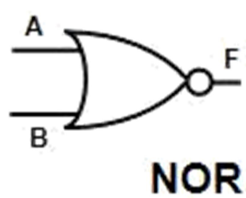
| Inputs | | Output |
|---|---|---|
| A | B | F |
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 1 | 1 |

**NOR gate (IC 7402):**

**Pin diagram:**




**Logic symbol:**




**Truth table:**

| Inputs | | Output |
|---|---|---|
| A | B | F |
| 0 | 0 | 1 |
| 1 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |

**Procedure: -**

1. The IC’s are tested for their correctness using IC tester.
2. Mount the IC’s on the IC base properly provided on the trainer kit.
3. Connect pin no. 7 to ground and pin no. 14 to $+V_{CC}$.

4. Then connect the input pins to inputs switches and output pins to output LED's.
5. Switch ON the supply to the trainer kit.
6. Apply the possible combination of inputs and observe the outputs.
7. Repeat the above procedure to verify the truth tables of OR and NOR gates.
8. Then switch OFF the supply.

**Observations:**

**Table 01:- Truth Table of OR Gate**

| INPUTs | | Theoretical OUTPUT | Output observed |
|---|---|---|---|
| A | B | $Y = A+B$ | $Y_1 = A+B$ |
| 0 | 0 | 0 | |
| 0 | 1 | 1 | |
| 1 | 0 | 1 | |
| 1 | 1 | 1 | |

**Table 02: Truth Table of NOR Gate**

| INPUTs | | Theoretical OUTPUT | Output observed |
|---|---|---|---|
| A | B | $Y = \overline{A+B}$ | $Y_1 = \overline{A+B}$ |
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 1 | 0 | 0 | |
| 1 | 1 | 0 | |

**Result:** The IC's 7432 and 7402 are tested and the truth-table for OR and NOR logic gates are verified.

# Ex. 14: Test IC's 7404 And 7486 And Verify the Truth-Table For NOT and XOR Logic Gates.

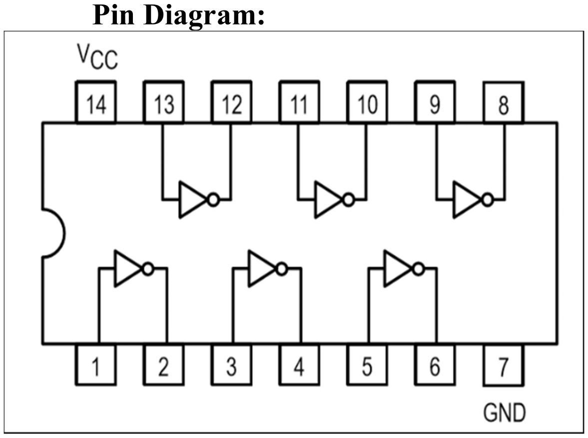
**AIM :** To test IC's 7404 and 7486 and Verify the truth-table for NOT and XOR logic gates.

**Materials required:**

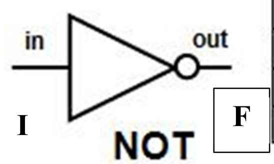
| Sl.No | Apparatus | Quantity |
|---|---|---|
| **1** | Digital IC Trainer | 01 |
| **2** | NOT Gate IC 7404 | 01 |
| **3** | XOR Gate IC 7486 | 01 |
| **4** | Patch cords | As per requirements |

**NOT gate (7404):**

**Pin Diagram:**




**Logic symbol:**

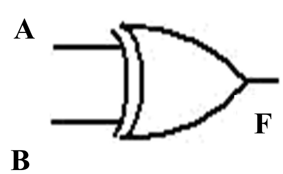



**Truth table:**

| Input | Output |
|---|---|
| I | F |
| 0 | 1 |
| 1 | 0 |

**XOR gate (7486):**

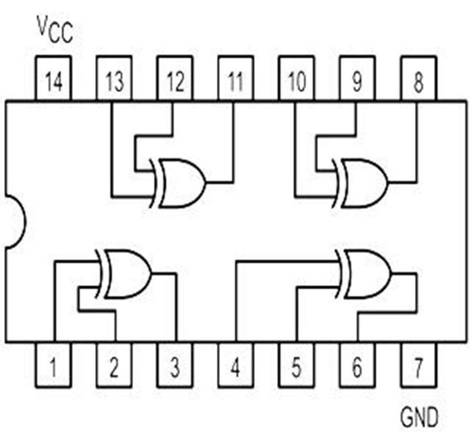
**Logic symbol:**




**Truth table:**

| Inputs | | Output |
|---|---|---|
| A | B | F |
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**Pin diagram:**



**Procedure: -**

1. The IC's are tested for their correctness using IC tester.
2. Mount the IC's on the IC base properly provided on the trainer kit.
3. Connect pin no. 7 to ground and pin no. 14 to $+V_{CC}$.
4. Then connect the input pins to inputs switches and output pins to output LED's.
5. Switch ON the supply to the trainer kit.
6. Apply the possible combination of inputs and observe the outputs.
7. Repeat the above procedure to verify the truth tables of OR and NOR gates.
8. Then switch OFF the supply.

**Observations:**

**Table 01:- Truth Table of INVERTER Gate**

| INPUT A | Theoretical OUTPUT $Y = \overline{A}$ | Output observed $Y_1 = \overline{A}$ |
|---|---|---|
| 0 | 1 | |
| 1 | 0 | |

**Table 02: Truth Table of XOR Gate:**

| INPUTS | | Theoretical Output | Output Observed |
|---|---|---|---|
| A | B | $F = (A \oplus B)$ | $Y1 = (A \oplus B)$ |
| 0 | 0 | 0 | |
| 0 | 1 | 1 | |
| 1 | 0 | 1 | |
| 1 | 1 | 0 | |

**Result:** The IC's 7404 and 7486 are tested and the truth-table for NOT and XOR logic gates are verified.

# Ex.15 Connect the Single- phase transformer as Step-Up, Step-Down transformer and verify the transformation ratio.

**Aim:** To connect the Single- phase transformer as Step-Up, Step-Down transformer and verify the transformation ratio.

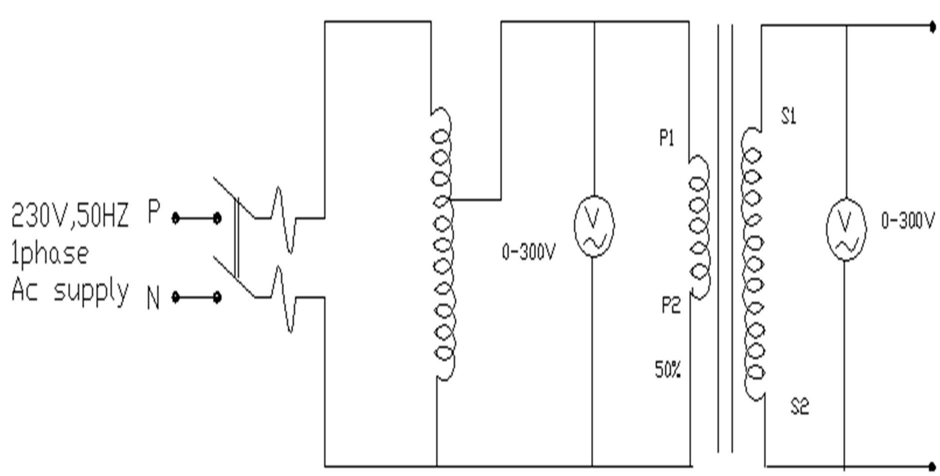
**Materials required:**

| Sl No. | Equipments | Specifications | Quantity |
|---|---|---|---|
| 1 | Single phase transformer | 230V / 230V,50 Hz. | 1 |
| 2 | AC voltmeter | 0–300 V | 2 |
| 3 | 1 Φ dimmerstat | 0–300V | 1 |
| 4 | Switch | DPST | 2 |
| 5 | Connecting wires | | Lumpsum |

**Circuit diagram:**

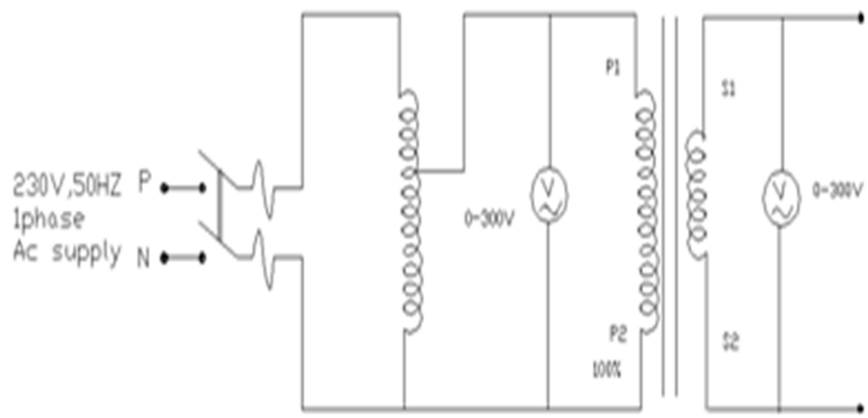
**1.Step-up transformer:**

**Figure (a)**



**2.Step-down transformer:**

**Figure (b)**




**Procedure:**

1. Connections are made as per the circuit diagram shown in figure (a)
2. Keep the dimmerstat in zero position and ensure that the voltmeter pointers are in zero position.
3. Switch ON the supply and apply voltage to the primary winding of the transformer.
4. Note down the voltmeter readings $V_1$ and $V_2$ in the tabular column.
5. Switch OFF the supply.
6. Change the tappings on both primary and secondary winding of the transformer as per figure (b)
7. Repeat the above procedure tabulate the readings and calculate the transformation ratio using the equation:

$$K = \frac{V2}{V1}$$

## Tabular column:

| SL NO | $V_1$ Volts | $V_2$ volts | Transformation ratio K $= \frac{V2}{V1}$ | Inference |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |

**Result:** The Single- phase transformer is connected as Step-Up, Step-Down transformer and the transformation ratio is verified.

## Ex.16 Construct a suitable circuit to Start and Reverse the direction of three phase Induction Motor using DOL starter.

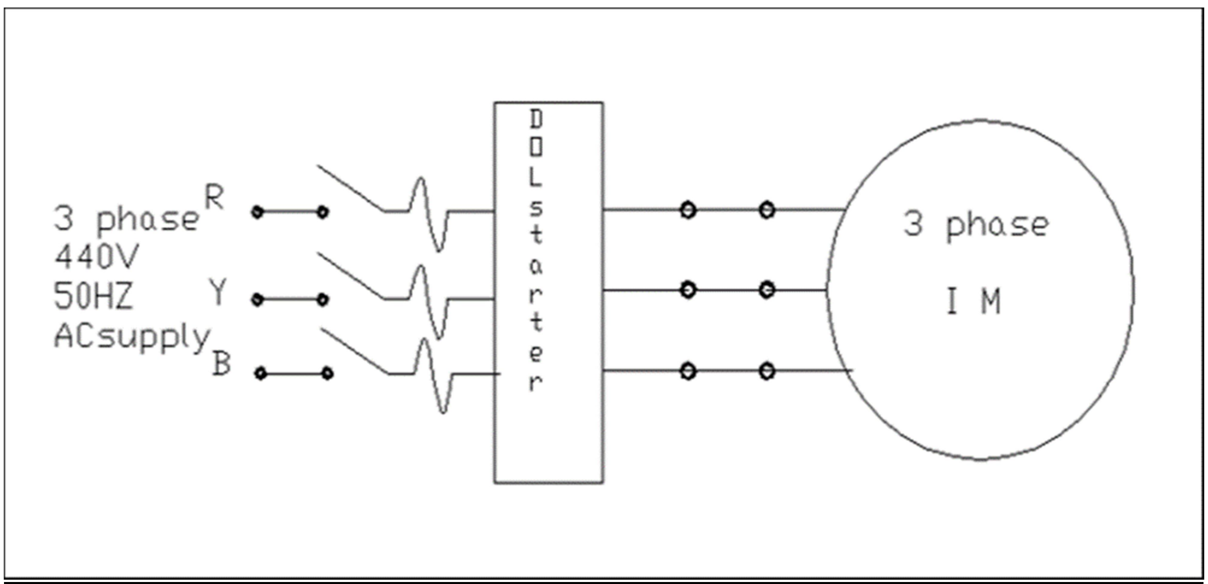
**Aim:** To construct a suitable circuit to start and reverse the direction of three phase induction motor using DOL starter.

.

**Materials required:**

| Sl NO | Materials Required | Specification/range | Quantity |
|---|---|---|---|
| 1 | Induction motor | 3phase 5 hp 440V | 1 |
| 2 | DOL starter | 5 hp 440 V | 1 no |
| 3 | Digital tachometer | | 1 no |
| 4 | TPST switch | 0-60 V 32 A | 1 no |
| 5 | Connecting wire | | lumpsum |

**Circuit diagram:**




**Procedure: -**

1. Note down the name plate details of the 3 phase squirrel cage IM and the DOL starter.
2. Connections are made as per the circuit diagram.
3. Close the supply switch and start the motor by pressing the START button of the starter.
4. Measure the speed of the motor using a tachometer and tabulate in the tabular column along with the direction of rotation of the motor.
5. Switch OFF the motor using STOP button of the starter.
6. Open the main supply switch.

7. To change the direction of rotation of the motor, interchange any two supply terminals and repeat the steps from 3 to 6.

**Tabular column:**

| **Direction of rotation of the motor** | **Speed in RPM** |
|---|---|
| Clockwise direction | |
| Anticlockwise direction | |

**Result**: The given 3 phase IM is connected to 3 phase supply started using the DOL starter and the direction of rotation of the motor is observed.

## Ex. 17 Identify the terminals of a diode and test the diode for its condition

**Aim**: To identify the terminals of a diode and test the diode for its condition.

**Materials required: -**

| Sl.No | Apparatus | Range | Quantity |
|---|---|---|---|
| 1 | Digital Multimeter | - | 01 |
| 2 | Diodes | - | As required |

**Circuit diagram: -**

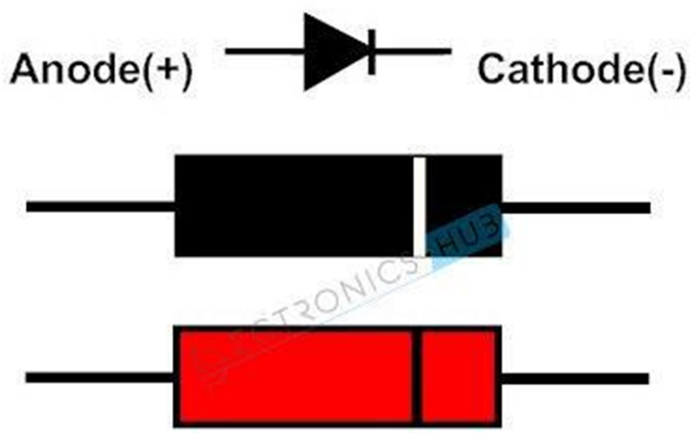



**Fig 1. Diode terminals**

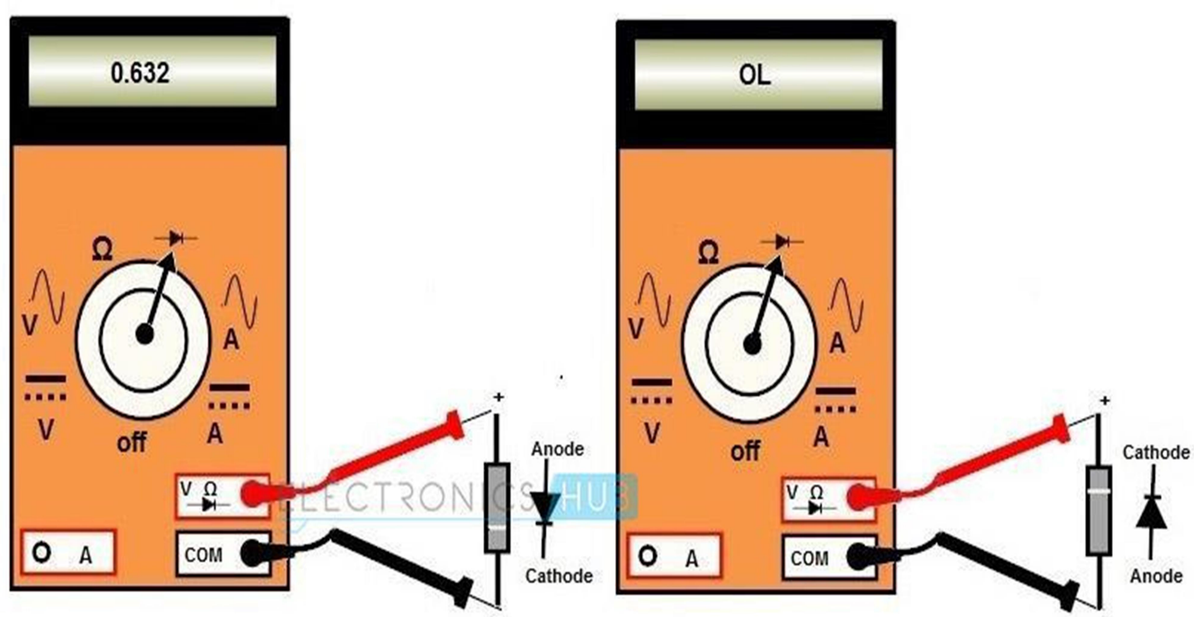



**Fig 2. Test circuit**

**Procedure: -**

1. Identify the terminals anode and cathode of the diode.

2. Keep the digital multimeter (DMM) in resistance or ohmmeter mode by rotating the central knob or selector to the place where ohm symbol or resistor values are indicated. Keep the selector in low resistance (may be 1K ohm) mode for forward-bias.

3. Connect the red probe to the anode and black probe to the cathode. This means diode is forward-biased. When the diode is forward-biased, the resistance of the diode is small.

4. If the meter displays a moderately low value on the meter display, then the diode is good and healthy.

5. Now reverse the terminals of the multimeter such that anode is connected to black probe and cathode to red probe. So, the diode is reverse biased.

6. Keep the selector in high resistance mode (may be 100K ohm) for the reverse bias testing procedure.

7. If the meter shows a very high resistance value or OL on meter display, then the diode is good and functions properly. Since in reverse biased condition diode offers a very high resistance.

**Result:** The terminals of a diode are identified and the diode is tested for its condition.

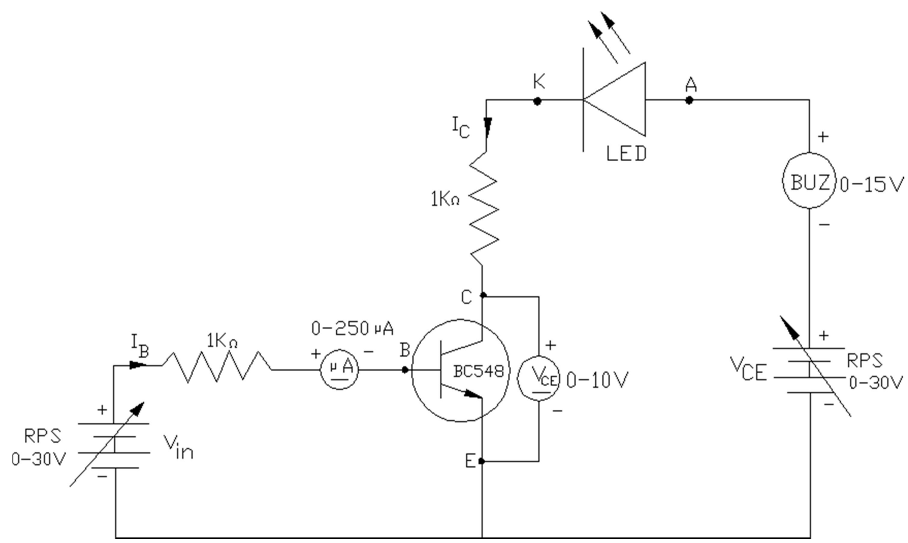
## Ex. 18 Construct and test the transistor as an electronic switch.

**Aim:** To construct and test the transistor as an electronic switch.

**Materials required:**

| SL NO | Equipments/meters | Range | quantity |
|---|---|---|---|
| 1 | Regulated power supply | 0-30 V , 2 A | 2 nos |
| 2 | Transistor | BC 548 | 1 no |
| 3 | Resistor | 1 KΩ, 0.5W | 2 nos |
| 4 | LED | | 1 no |
| 5 | Buzzer | 0-15 V | 1 no |
| 6 | Bread board | | 1 no |
| 7 | Connecting wires | | lumpsum |

**Circuit diagram:**




**Procedure:**

1. Make the connections as per circuit diagram.
2. Keep the current setting knob of the RPS in maximum position and voltage setting knob of the RPS in minimum position.
3. Switch "ON" both the RPS, set '$V_{in}$' to zero volts and '$V_{CE}$' to 15 V.
4. Observe the status of the LED and buzzer and note down '$I_B$' and '$V_{in}$' in the tabular column.
5. Now increase the voltage $V_{in}$ ($V_{BE}$) voltage till buzzer and LED turns "ON".
6. Note down the values of $I_B$, $V_{CE}$ and $V_{BE}$ in the tabular column.
7. Reduce the voltage of both the RPS to zero and then switch "OFF" the supplies.

**Tabular column:**

| Sl no. | $V_{in}$ volts | $V_{CE}$ volts | $I_B$ µA | Indication of the device | | Status of the transistor |
|---|---|---|---|---|---|---|
| | | | | LED | Buzzer | |
| | | | | | | |
| | | | | | | |

**Results:** The transistor is tested for its operation as an electronic switch.

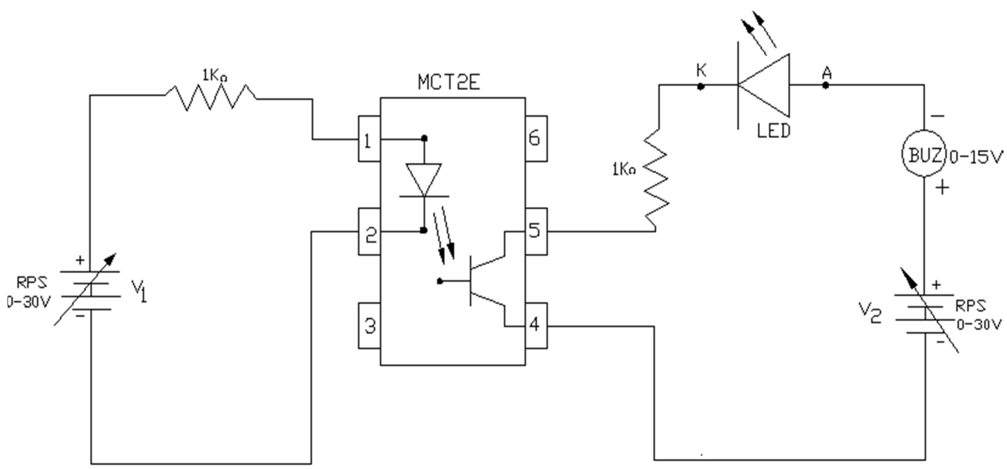
## Ex. 19: Construct and test the opto-isolator as an electronic switch.

**Aim:** To construct and test the circuit of Opto-isolator as a switch.

### Materials required:

| Sl no. | Equipment/Meters | Range | Quantity |
|---|---|---|---|
| 1. | Regulated power supply | 0-30V,2A | 2 nos. |
| 2. | Opto-isolator | MCT2E | 1 no. |
| 3. | Resistor | 1KΩ,0.5W | 2 nos. |
| 4. | LED | | 1 no. |
| 5. | Buzzer | 0-15V | 1 no. |
| 6. | Bread board | | 1 no. |
| 7. | Connecting wires | | lumpsum |

### Circuit diagram: -




### Procedure:

1. Connections are made as shown in the circuit diagram.
2. Keep the current setting knob of the RPS in maximum position and voltage setting of the RPS in minimum position.
3. Switch "ON" both the RPS, set '$V_1$' to zero volts and '$V_2$' to 15 V
4. Observe the status of the LED and buzzer and note down the values of '$V_1$' and '$V_2$' in the tabular column.
5. Now increase the voltage 'V1' in steps until the buzzer and LED are turned "ON".

6. Also, note down the values of V1 and V2 in the tabular column
7. Reduce the voltage of both the RPS to zero and then switch “OFF” the supplies.

**Tabular column:**

| **Sl no.** | **$V_1$ volts** | **$V_2$ volts** | **Indication of the device** | | **Status of the Opto-isolator** |
|---|---|---|---|---|---|
| | | | **LED** | **Buzzer** | |
| | | | | | |
| | | | | | |

**Result:** The Opto-isolator as a switch is verified experimentally.