EXPERIMENT NO. 1

Object: To identify, measure and test (using multimeter)Carbon Resistors

Things Required:

(1) Digital multimeter
(2) Color code table

Theory of Resistors:

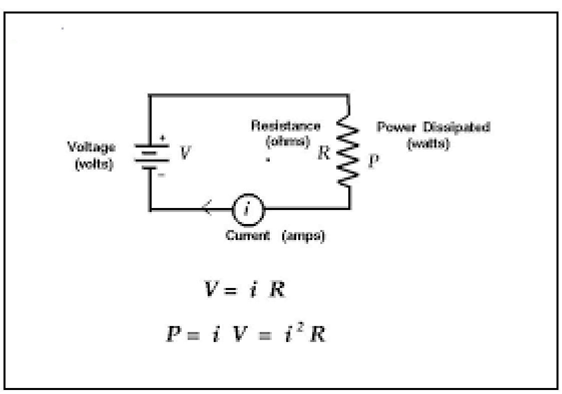
Resistors are discrete electronic components which are connected in electronic circuit to introduce particular value of resistance. Its unit is Ohm(Ω).

1Ω = 1000 mΩ
1 KΩ = 1000 Ω
1 MΩ = 1000 KΩ

Symbol and Equations relating Voltage, Current, Resistance and Power:

Ohm's Law R=V/I
Power Dissipation P=I*I*R
P=V*V/R

Where
R denotes value of Resistance
V denotes Voltage across resistor
I denotes Current passing through resistor
P denotes Power dissipated in resistor

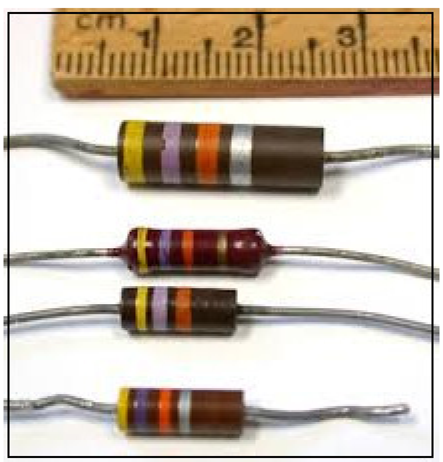


Types of resistors:

Wire wound resistors- Metallic wire is wound around air/ceramic core. It used to make small value of resistance (less than few ohms). Variable resistance called potentiometer is wire wound resistor.

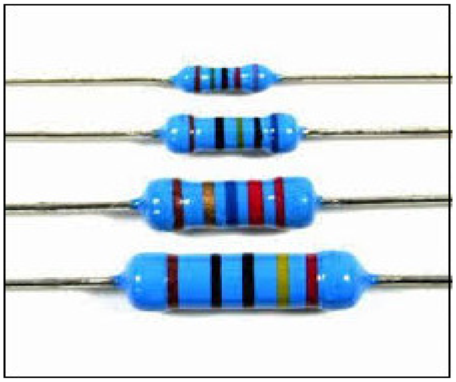
Carbon resistor-

1. Carbon resistors are made by mixing carbon powder in appropriate quantity with binding material and packaged in plastic container of cylindrical shape.
2. Two wires at the ends are terminals for making connection with the circuit.
3. Four Color bands or Five color bands are marked around the surface of resistor to denote the value of resistor in ohms.
4. Resistors are available in market of the power ratings of 0.25 watt, 0.5watt, 1.0watt, 2.0 watt.
5. Resistors are available in market in multiples of 10 of value 1, 5, 12, 15, 22, 47, 68 etc.



Metal film resistor-

1. Metal film resistors are made by placing slotted metal film over ceramic core and packaged in plastic container of cylindrical shape.
2. Two wires at the ends are terminals for making connection with the circuit.
3. Four Color bands or Five color bands are marked around the surface of resistor to denote the value of resistor in ohms.
4. Resistors are available in market of the power ratings of 0.25 watt, 0.5watt, 1.0watt, 2.0 watt, 5.0watt and 10.0 watt or higher

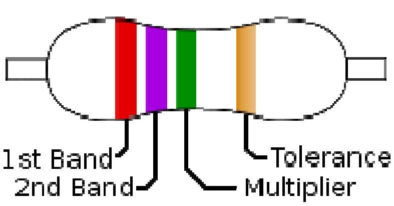


Color code for Resistor:

S.No.	Color	Value	Multiplier	Tolerance
1	Black	0	1	-
2	Brown	1	10	-
3	Red	2	100	-
4	Orange	3	1000	-
5	Yellow	4	10000	-
6	Green	5	100000	-
7	Blue	6	1000000	-
8	Voilet	7	10000000	-
9	Grey	8	100000000	-
10	White	9	1000000000	-
11	Gold	-	0.1	+/- 5%
12	Silver	-	0.01	+/- 10%
13	None	-	-	+/- 20%

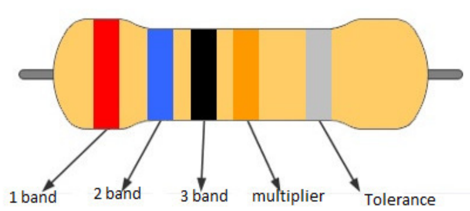
Four Color bands Resistor:

1. First band denotes the value in decimal digit
2. Second band denotes the value in decimal digit
3. Third color band is multiplier of 10.
4. Fourth color band denotes Tolerance.



Five Color bands Resistor:

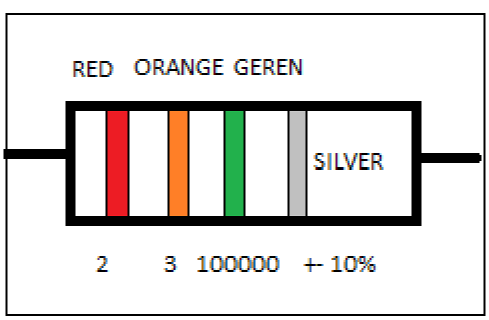
1. First band denotes the value in decimal digit
2. Second band denotes the value in decimal digit.
3. Third band denotes the value in decimal digit.
4. Fourth color band is multiplier of 10.
5. Fifth color band denotes Tolerance.



Applications of Resistors:

1. Limiting current in circuit.
2. Potentiometer is used as volume control in audio circuits.
3. Presets are used in electronic circuits for presetting resistance while testing electronic circuit.
4. Resistors are used as heating filament.
5. Resistors are used as lighting filament in bulbs.

Reading value of resistance from color code:



Resistance =2300000Ω +/- 10%

Max. resistance =2300000Ω + 23000 =2530000Ω
=2530KΩ
Min. resistance =2300000Ω -230000 =2070000Ω

=2070KΩ

Testing the Resistor using Multimeter:

1. Adjust the selector switch of Digital multimeter to read OHM.
2. Connect the two probes across terminals of resistor.
3. Read value on display.

Conclusion:-

Different resistors have been identified , their values are measured using color code and Digital multimeter . Experiment is completed successfully.

EXPERIMENT NO. 2

Object: To identify, measure and test Capacitors

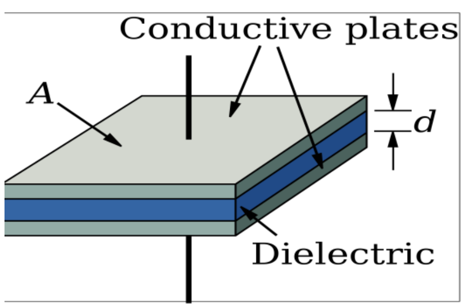
Things Required:

(1) Digital multimeter

Theory of Capacitors:

1. A capacitor (or condenser) is a passive two-terminal electrical component used to store electrical energy temporarily in an electric field.
2. A capacitor contains at least two electrical conductors (plates) separated by a dielectric (i.e. an insulator that can store energy by becoming polarized).
3. The plates can be thin films, foils or sintered beads of metal or conductive electrolyte etc.
4. The nonconducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics are glass, ceramic, plastic film, air, vacuum, paper, mica, and oxide layers.
5. The unit of capacitance is the farad (F), which is equal to one coulomb per volt (1 C/V). Typical capacitance values range from about 1 pF (10^{-12} F) to about 1 mF (10^{-3} F).

1 picofarad=1pF=10^{-12} F
1microfarad=1μF=10^{-6} F
1millifarad=1Mf=10^{-3} F



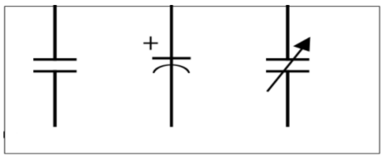
Symbol and Equations relating Voltage, Current, Resistance and Power:

1.Charged stored in capacitor Plates Q = C×V
2.Energy stored in a charged capacitor E= C×V^2
3.Capacitance C= εA/D

Where
C denotes value of Capacitance
V denotes Voltage across capacitor
Q denotes Charge on plates of capacitor

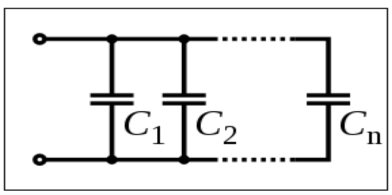
E denotes Energy stored in capacitor
A denotes surface area of plate
D denotes distance between plates
ε denotes permitivitty of dielectric material between plates

Symbol for capacitor:



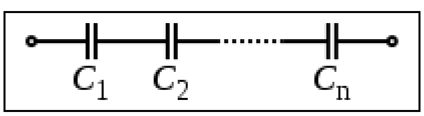
Parellel connection of capacitors:

$C = C_1+C_2+\text{-------} + C_n$

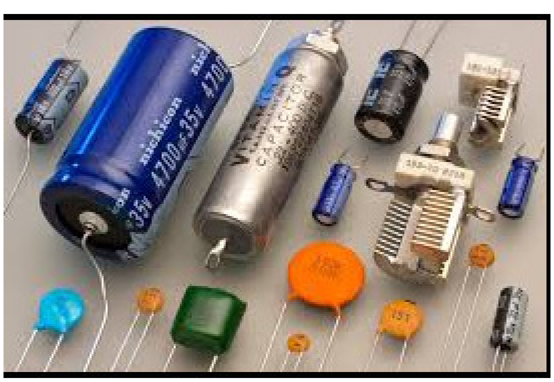


Series connection of capacitors:

$1/C = 1/C_1+ 1/C_2 +\text{-------} + 1/C_n$



Types of capacitors:



Electrolytic capacitor:

An **aluminum electrolytic capacitor**, usually simply called an **electrolytic capacitor** (e-cap), is a capacitor whose anode (+) consists of pure aluminum foil with an etched surface, covered with a uniformly very thin barrier layer of insulating aluminum oxide, which operates as a dielectric. The electrolyte (wet or solid),acts as cathode (-).These are inexpensive with widest range of sizes, capacitance and voltage values. They are made with capacitance values from 0.1 µF up to 2,700,000 µF (2.7 F),[1] and rated voltages values from 4 V up to 630 V. Aluminum electrolytic capacitors are polarized capacitors. They can only be operated with DC voltage applied with the correct polarity. Operating the capacitor with wrong polarity or with AC voltage leads to a short circuit and can destroy the component.

Ceramic capacitor:

A **ceramic capacitor** is a fixed value capacitor in which ceramic material acts as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes. The composition of the ceramic material defines the electrical behavior and therefore applications.

Plastic film capacitors:

Plastic film capacitors, generically called power film capacitors, are electrical capacitors with an insulating plastic film as the dielectric, sometimes combined with paper.The dielectric films, depending on the desired dielectric strength, are drawn in a special process to an extremely thin thickness, and are then provided with electrodes. The electrodes of film capacitors may be metallized aluminum or zinc applied directly to the surface of the plastic film.

Specifications of capacitors:

Most capacitors have numbers printed on their bodies to indicate their electrical characteristics:

1. The working voltage of a capacitor is the highest voltage that can be applied across it without undue risk of breaking down the dielectric layer. Working voltage is printed in volts.
2. Larger capacitors like electrolytics usually display the actual capacitance together with the unit (for example, 220 µF).
3. Smaller capacitors like ceramics, however, use a shorthand consisting of three numeric digits and a letter, where the digits indicate the capacitance in pF -
4. XYZ followed by JorKorM (calculated as XY × 10^Z for digits XYZ) and the letter indicates the tolerance (J, K or M for ±5%, ±10% and ±20% respectively).

Example:

- A ceramic capacitor with the text 473K 330V on its body has a capacitance of 47 × 10^3 pF = 47 nF (±10%) with a working voltage of 330 V.
- An electrolytic capacitor with the text 1000µF, 63volts.

Applications of Capacitors:

1. Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass i.e. coupling capacitor.
2. In analog filter networks, they smooth the output of rectifier power supplies.

3. In resonant circuits, they tune radios, TV, Smart phones to particular frequencies.
4. In electric power transmission systems, they stabilize voltage and power flow.
5. In motor circuits, they are connected to improve power factor.

Testing the capacitor using Multimeter:

1. Adjust the selector switch of Digital multimeter to read Farad.
2. Connect the two probes across terminals of capacitor.
3. Read value on display.

Conclusion:-

Different capacitors have been identified and their values are measured using Digital multimeter. Experiment is completed successfully.

An **aluminum electrolytic capacitor**, usually simply called an **electrolytic capacitor** (e-cap), is a capacitor whose anode (+) consists of pure aluminum foil with an etched surface, covered with a uniformly very thin barrier layer of insulating aluminum oxide, which operates as a dielectric. The electrolyte, which covers the rough surface of the oxide layer, operates as the second electrode, the cathode (-). E-caps have the largest capacitance values per unit volume compared to the two other main conventional capacitor families, ceramic and plastic film capacitors, but articulately smaller capacitance than similar sized supercapacitors.

Aluminum electrolytic capacitors are divided into three subfamilies by the type of electrolyte:

- non-solid (liquid, wet) aluminum electrolytic capacitors,
- solid manganese dioxide aluminum electrolytic capacitors, and
- solid polymer aluminum electrolytic capacitors.

Aluminum electrolytic capacitors with non-solid electrolyte are the most inexpensive type and also those with widest range of sizes, capacitance and voltage values. They are made with capacitance values from 0.1 µF up to 2,700,000 µF (2.7 F),[1] and rated voltages values from 4 V up to 630 V.[2] The liquid electrolyte provides oxygen for re-forming or self-healing of the dielectric oxide layer. However, it can evaporate through a temperature-dependent drying-out process, which causes electrical parameters to drift, limiting the service life time of the capacitors.

Due to their relatively high capacitance values aluminum electrolytic capacitors with their relatively high capacitance values have low impedance values even at lower frequencies like mains frequency. They are typically used in power supplies, switched-mode power supplies and DC-DC converters for smoothing and buffering rectified DC voltages in many electronic devices as well as in industrial power supplies and frequency converters as DC link capacitors for drives, inverters for photovoltaic, and converters in wind power plants. Special types are used for energy storage, for example in photoflash or strobe applications or for frequency coupling in audio applications.

Aluminum electrolytic capacitors are polarized capacitors because of their anodization principle. They can only be operated with DC voltage applied with the correct polarity. Operating the capacitor with wrong polarity or with AC voltage leads to a short circuit and can destroy the component. The exceptions is the bipolar aluminum electrolytic capacitor, which has a back-to-back configuration of two anodes in one case and can be used in AC applications.

A **ceramic capacitor** is a fixed value capacitor in which ceramic material acts as the dielectric. It is constructed of two or more alternating layers of ceramic and a metal layer acting as the electrodes.

The composition of the ceramic material defines the electrical behavior and therefore applications. Ceramic capacitors are divided into two application classes:

- Class 1 ceramic capacitors offer high stability and low losses for resonant circuit applications.
- Class 2 ceramic capacitors offer high volumetric efficiency for buffer, by-pass, and coupling applications.

plastic film capacitors, **film dielectric capacitors**, or **polymer film capacitors**, generically called “film caps” as well as power film capacitors, are electrical capacitors with an insulating plastic film as the dielectric, sometimes combined with paper as carrier of the electrodes. The dielectric films, depending on the desired dielectric strength, are drawn in a special process to an extremely thin thickness, and are then provided with electrodes. The electrodes of film capacitors may be metallized aluminum or zinc applied directly to the surface of the plastic film, or a separate metallic foil overlying the film. Two of these conductive layers are wound into a cylinder shaped winding, usually flattened to reduce mounting space requirements on a printed circuit board, or layered as multiple single layers stacked together, to form a capacitor body. Film capacitors, together with ceramic capacitors and electrolytic capacitors, are the most common capacitor types for use in electronic equipment, and are used in many AC and DC microelectronics andelectronics circuits.[1]

EXPERIMENT NO. 3

Object: To identify and test discreet components and semiconductor components and ICs.

Things Required:
(1) Digital multimeter
(2) Components

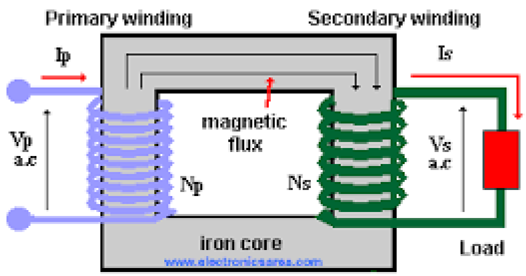
Theory:
1. Tranformer:

A **transformer** is an electrical device that transfers electrical energy between two or more circuits through electromagnetic induction. A varying current in the transformer's primary winding creates a varying magnetic flux in the transformer core and a varying field impinging on the transformer's secondary winding. This varying magnetic field at the secondary winding induces a varying electromotive force (EMF) or voltage in the secondary winding due to electromagnetic induction. Transformers are used to increase (step up) or decrease (step down) the alternating voltages in electric power applications. Specification of transformer is mainly current capacity and secondary voltage i.e 500 ma, 12V-0-12V.

To test the working condition of a step down transformer, connect the two probes of digital multimeter to the two ends of primary winding. Put selector switch to Ω position. It will show few ohms i.e 10 Ω, 18 Ω. Then connect two probes to secondary winding side. It will show lesser ohms than primary. It will show high resistance for open winding. The beep will blow when windings are shorted.

Fig. 1 Transformer

Fig. 2 Functional diagram of Transformer



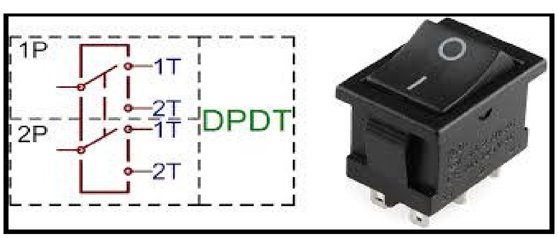
2. Switch:

A **switch** is an electrical component that can break an electrical circuit. The mechanism of a switch may be operated directly by a human operator to control a circuit (for example, a light switch or a computer keyboard button), may be operated by a moving object such as a door-operated switch, operated by some sensing element for pressure, temperature or flow. A relay is a switch that is operated by electricity. Switches are made to handle a wide range of voltages and currents. An ideal switch would have no voltage drop when closed, and would have no limits on voltage or current rating. It would have zero rise time and fall time during state changes, and would change state without "bouncing" between on and off positions. The mechanism actuating the transition between these two states (open or closed) can be either a "toggle switch" or "push button switch.

To test the working condition and to identify terminals of switch, use digital multimeter in "continuity test position". Connect the probes between different terminals and toggle the switch to identify connection points.

Fig. 3 Pushbutton Switch

Fig. 4 Toggle Switch



3. Buzzer:

A **buzzer** or **beeper** is an audio signaling device which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke.

To test the buzzer, use digital multimeter in "continuity test position". Beep will blow for OK condition.

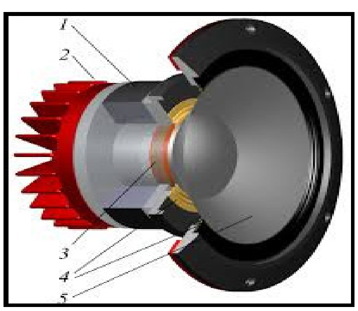
Fig. 5 Buzzer

4. Speaker:

A speaker is a transducer which converts electrical signal into audio signal. The output of a speaker may be in the frequency range from 20 Hz to 15000Hz. **Computer speakers**, are speakers sold for use with computers have an internal amplifier and require a power source, which may be by a mains power supply often via an AC adapter, batteries, or a USB port (able to supply no more than 2.5W DC, 500mA at 5V). The signal input connector is often a 3.5 mm jack plug. Battery-powered wireless Bluetooth speakers require no connections at all. Speakers used with Public address system (P A system) have higher watts 50watts-1000watts. The amplifier is connected separately. Main specifications for speaker are Wattage, resistance, frequency range.

To test the working condition of a speaker, connect the two probes of digital multimeter to the two ends of speaker audio input. Put selector switch to Ω position. It will show ohms as rated i.e 4 Ω, 8 Ω.

Fig. 5 Speaker

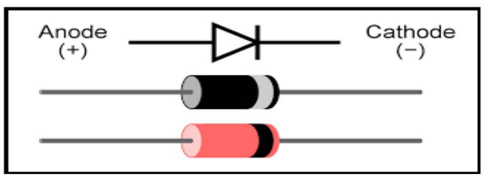


6. Diode

A diode is a two-terminal electronic component that conducts primarily in one direction. It has low (ideally zero) resistance to the flow of current in one direction (Forward bias), and high (ideally infinite) resistance in the other direction (reverse bias). A **diode** has a p–n junction connected to two electrical terminals. Diodes are made of silicon, selenium or germanium. This unidirectional behavior is called rectification, and is used to convert alternating current to direct current, these diodes are forms of rectifiers. Types of diode are zener diode, Avalanche diode, tunnel diode, schottky diode.

To test the working condition and to identify terminals of diode, use digital multimeter in "continuity test position". Connect the probes between two terminals diode. When the diode is forward biased, the beep will blow. The terminal connected to ground (black probe) is cathode and other is anode. Reverse the terminals of multimeter, now diode must be in reverse bias and show very high resistance.

Fig. 7 Diode and its symbol

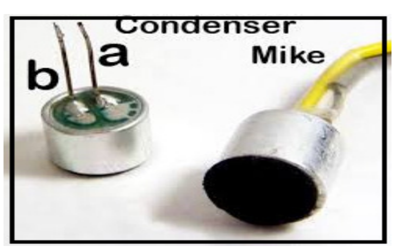


7. Microphone:

A **microphone**, is an acoustic-to-electric transducer or sensor that converts sound into an electrical signal. Electromagnetic transducers facilitate the conversion of acoustic signals into electrical signals. Types of microphones are electromagnetic induction (dynamic microphones), capacitance change (condenser microphones) or piezoelectricity (piezoelectric microphones) to produce an electrical signal from air pressure variations. Microphones typically need to be connected to a preamplifier before the signal can be amplified with an audio power amplifier and a speaker.

Microphones are used in many applications such as telephones, hearing aids, public address systems for concert halls and public events, motion picture production, live and recorded audio engineering, two-way radios, megaphones, radio and television broadcasting, and in computers for recording voice, speech recognition etc.

Fig.8 Condenser mike

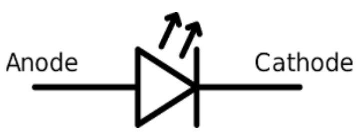


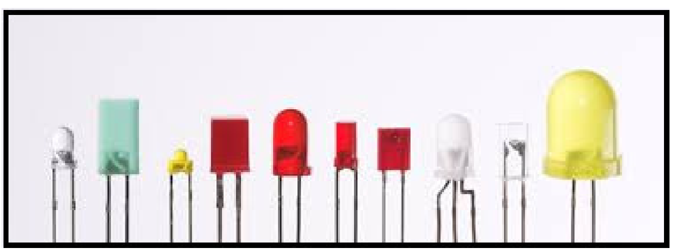
8. LED:

A **light-emitting diode** (**LED**) is a two terminal semiconductor light source. It is a p–n junction diode, which emits light when activated. When forward bias is applied to the terminals, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. Gallium arsenide (GaAs), Gallium arsenide phosphide (GaAsP), Gallium indium arsenide (Ga InAs) materials are used to make LEDs. It is used as indicator and in displays boards.

To test the working condition and to identify terminals of LED, use digital multimeter in "continuity test position". Connect the probes between two terminals diode. When the LED is forward biased, it will glow.

Fig. 9 LEDs and symbol





9. Transistor:

A **transistor** is composed of semiconductor material with at least three terminals (emitter, collector and base) for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals changes the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. This property is called gain. It can produce a stronger output signal, a voltage or current, which is proportional to a weaker input signal; that is, it can act as an amplifier.

The transistor can also be used to turn current on or off a circuit and then it is called a switching transistor. Some transistors are packaged individually, but many more are found embedded in integrated circuits(IC). Types of transistors are BJT, FET etc.

To test the working condition and to identify terminals of transistor, use digital multimeter in "continuity test position". Connect the probes between base and emitter terminals, the beep will blow showing forward bias. Then connect the probes between base and collector terminals, the resistance will be high due to reverse bias. The transistor is O.K.

Fig. 10 Transistors

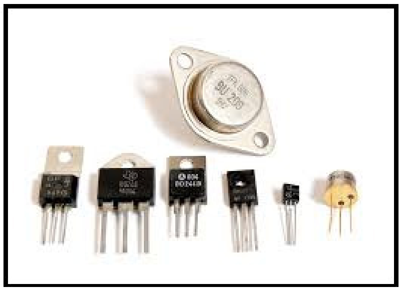
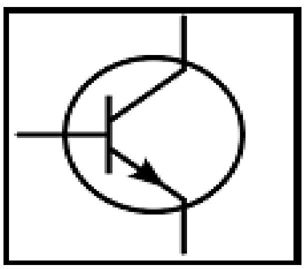


Fig. 11 Symbol of Transistor



10. Integrated Circuit

An **integrated circuit** (also referred to as an **IC**, a chip, or a microchip) is a set of electronic circuits on one small wafer of semiconductor material, normally silicon. This can be made much smaller than a discrete circuit made from discreet electronic components. ICs can be made very compact, having up to several billion transistors and other electronic components in an area the size of a one sqcm.SSI, **MSI, LSI,VLSI, ULSI** are different levels of integration of logic gates on single chip.**DIP(Dual–in-line Package)**ICs are low cost ICs for making Simple analog and Digital circuits. **SOIC (Small Outline Integrated Circuit)** are expensive ICs used in Motherboards, Mobiles etc.

Acronym	**Full Name**	**Year**	**Number of Logic Gates**
SSI	Small Scale Integration	1964	1 to 12
MSI	Medium Scale Integration	1968	13 to 99
LSI	Large Scale Integration	1971	100 to 999
VLSI	Very Large Scale Integration	1980	1000 to 9999
ULSI	Ultra Large Scale Integration	1984	10,000 above

Fig. 11 DIP IC(16 pin)

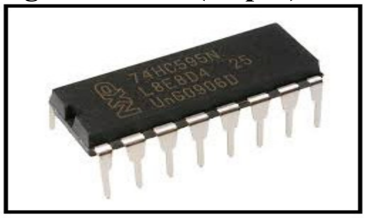


Fig. 12 SOIC(44 pin)

Conclusion:-

Different components have been identified and tested using Digital multimeter. Experiment is completed successfully.

EXPERIMENT NO. 4

Object: To solder discreet components on a general purpose PCB.

Things Required:

(1) Digital multimeter
(2) General purpose PCB
(3) Soldering iron
(4) Solder wire
(5) Jumper wire
(6) Flux
(7) Discreet components
(8) Solder iron stand

Theory:

Soldering is a process in which two or more items (usually metal) are joined together by melting and putting a solder wire into the joint, the solder wire has a lower melting point than the adjoining metal. Soldering differs from welding in that soldering does not involve melting the work pieces.
Electronic soldering connects electrical wiring and electronic components to printed circuit boards (PCBs).
Desoldering: When the joint becomes lose, or there is "cold solder" then desoldering is done to remove joint. A Desolder pump or Desolder wire is used for this purpose.

Solder wire Common solder wire is made of alloy of tin and lead (60% tin 40% lead) which melts between 183–190 °C.

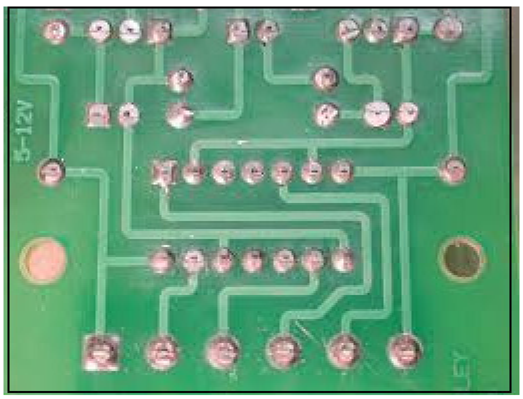
Flux: The purpose of flux is to facilitate the soldering process. One of the obstacles to a successful solder joint is an impurity at the site of the joint, for example, dirt, oil or oxidation. The impurities can be removed by mechanical cleaning or by chemical means, but the elevated temperatures required to melt the solder wire encourages the work piece (and the solder) to re-oxidize. Flux prevents formation of oxidation layer.

Soldering Iron: Hand soldering is typically performed with a soldering iron, soldering gun, or a torch, or occasionally a hot-air pencil.
The electric soldering iron can be fitted with a variety of tips ranging from blunt to very fine. It is available in different powers i.e 10 watt,15 watt, 25 watt etc. It also comes with temperature control feature.

Solder iron stand: It is used to hold the soldering iron while it is hot.

Procedure:

1. The soldering process requires
2. Cleaning of the metal parts to be joined
3. Fitting up the joint
4. Heating the parts
5. Applying flux
6. Applying solder wire
7. Removing heat and holding the assembly still until the solder wire has completely solidified.



Conclusion:-

Different components have been soldered on the general purpose PCB. The joint are tested using Digital Multimeter.

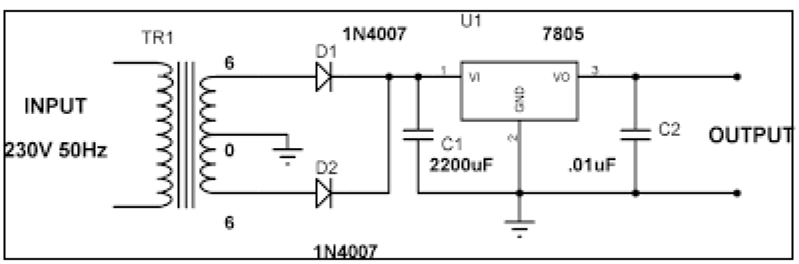
EXPERIMENT NO. 5

Object: To fabricate a rectifier circuit on a general purpose PCB and test its operation.

Things Required:

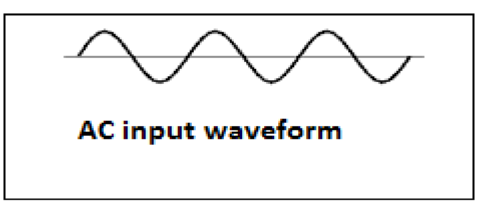
(1) Digital multimeter
(2) General purpose PCB
(3) Center-tapped transformer 6-0-6 volts, 250 mA
(4) IC 7805
(5) Two diode IN4007
(5) Electrolytic capacitor 2200µf,16 v, Electrolytic capacitor 0.01µf,16 v
(7) Soldering Kit, jumper wire

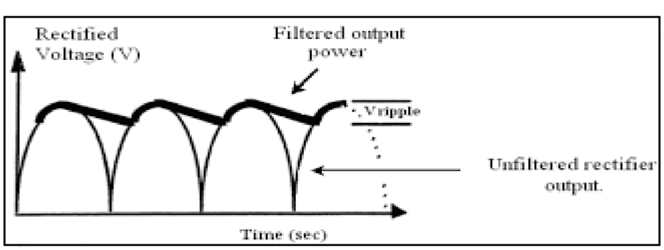
Circuit:



Theory:

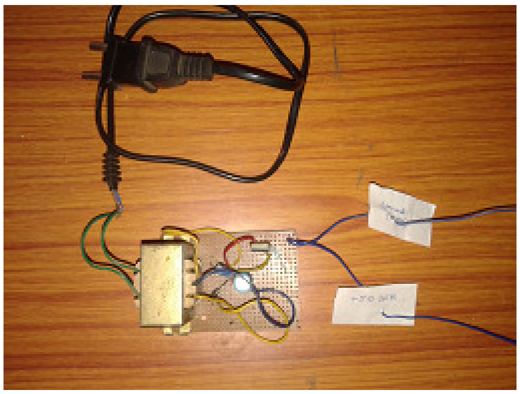
A full wave rectifier circuit is implemented using Center-tapped transformer and two diodes. IC 7805 is used for voltage regulation to give constant output voltage of 5 volts. Two Electrolytic capacitor are used to filter the ripples from output waveform.





Procedure:

(1) Collect all the enlisted components.
(2) Check all the components using multimeter before connecting on PCB.
(3) Connect the components according to circuit as shown above on General purpose PCB.
(4) Connect AC mains supply 230 volts, 50 Hz to primary wires of transformer.
(5) Check DC output 5volts across points A,B.



Conclusion:-

Different components have been identified and tested using Digital multimeter. Experiment is completed successfully.