Government College of engineering, keonjhar

DEPARTMENT OF ELECTRICAL ENGINEERING

LABORATORY MANUAL

Basic electronics engineering

NAME: ______________________________________

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GOVERNMENT COLLEGE OF ENGINEERING,KEONJHAR.

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CONTENT

Serial no.	Name of the Experiment	Page no.	Date of Performance	Date of Submission	Assessment Marks	Sign. of Teacher & Remarks
1	Familiarization with electronic components (Active & Passive) & electronic equipment’s (Multi-meters, CROs and function generators)					
2	Study of the V-I characteristics of P-N junction diode & Calculate DC & AC resistance.					
3	Construction of half-wave rectifier and full wave rectifier circuits (with & without Filter) & study of their output waveforms by CRO and calculation of efficiency and ripple factor					
4	Construction of positive, negative and biased clipper circuits & study of their output waveforms by CRO Construction of positive and negative clamper circuits & study of their output waveforms by CRO					
5	Design of inverting and non-inverting amplifiers using Op-Amp for a given gain with the help of breadboard and distinct components.					
6	Study and realization pf logic gates. (Truth table verification)					

EXPERIMENT NO:1

AIM OF THE EXPERIMENT

To familiarize with various Electronic Components such as;

- Passive Components
- Active Components

THEORY

Passive Components:

The electronic components which are not capable of amplifying or processing an electrical signal are called passive components such as resistors, capacitors & inductors. However, in electronic circuits, these components are important as active components because without the aid of these components, the active devices cannot process the electrical signals.

Resistors:

Resistors are the most commonly used of all electronic components, to the point where they are almost taken for granted. There are many different resistor types available with their principal job being to "resist" the flow of current through an electrical circuit, or to act as voltage droppers or voltage dividers. When used in DC circuits the voltage drop produced is measured across their terminals as the circuit current flows through them while in AC circuits the voltage and current are both in-phase producing 0^o phase shift.

Resistors produce a voltage drop across themselves when an electrical current flows through them because they obey Ohm's Law, and different values of resistance produces different values of current or voltage.

There are many types of resistors and they are classified based on their particular characteristics and accuracy suiting certain areas of application, such as High Stability, High Voltage, High Current etc, or are used as general purpose resistors where their characteristics are less of a problem. Some of the common characteristics associated with the humble resistor are; Temperature Coefficient, Voltage Coefficient, Noise, Frequency Response, Power as well as Temperature Rating, Physical Size and Reliability.

The unit of resistance, R is ohm and denoted by the Greek symbol ‗Ω'(omega).

Carbon Composition Resistors:

Carbon Composition Resistors are the cheap general purpose resistors. Their resistive element is manufactured from a mixture of finely ground carbon dust or graphite (similar to pencil lead) and a non-conducting ceramic (clay) powder to bind it all together. The ratio of carbon to ceramic determines the overall resistive value of the mixture and the higher this ratio is the lower the resistance. The mixture is then moulded into a cylindrical shape and metal wires or leads are attached to each end to provide the electrical connection before being coated with an outer insulating material and colour coded markings. CarbonComposite Resistors are low to medium power resistors with low inductance which makes them ideal for high frequency applications but they suffer from drawbacks like low stability, more noisy & high temperature co-efficient.

Typical Specifications:

- Available Range : 1Ω to 10MΩ
- Tolerance Range : ±5% to ±20%
- Wattage Range : 0.125 W to 2 W
- Operating temperature: -55°C to 100°C
- DC working voltage : up to 350V

Film Resistors:

The category of "Film Resistor" consist of Metal Film, Carbon Film and Metal Oxide Film resistor types, which are generally made by depositing pure metals, such as nickel, or an oxide film, such as tin-oxide, onto an insulating ceramic rod or substrate. The resistive value of the resistor is controlled by increasing the desired thickness of the filmand then by laser cutting a spiral helix groove type pattern into this film. This has the effect of increasing the conductive or resistive path. This method of manufacturing allows for much closer tolerance resistors (1% or less) as compared to the simpler carbon composition types. Metal Film Resistors have much better temperature stability than their carbon equivalents, lower noise and are generally better for high frequency or radio frequency applications. Metal Oxide Resistors have better, high surge current capability with a much higher temperature rating than the equivalent metal film resistors.Another type of film resistor commonly known as a Thick Film Resistor is manufactured by depositing a much thicker conductive paste of CERamic and METal, called Cermet, onto an alumina ceramic substrate. Cermet resistors have similar properties of metal film resistors and are generally used for making small surface mount chip type resistors, multi-resistor networks in one package for PCB's and high frequency resistors. They have good temperature stability, low noise, and good voltage ratings but low surge current properties.

Typical Specifications:

- Availabe Range: $10\Omega \ to \ 10M\Omega$
- Tolerance Range : ±5%
- Wattage Range : 0.25 W to 5 W
- Operating temperature : -55°C to 125°C
- DC working voltage : up to 750V

Wire-wound Resistors:

Wire-wound Resistors are made by winding a thin metal alloy wire (Nichrome) or similar wire onto an insulating ceramic former in the form of a spiral helix similar to the film resistors. These types of resistors are generally only available in very low ohmic high precision values due to the gauge of the wire and number of turns possible on the former making them ideal for use in measuring circuits and Whetstone bridge type applications. They are also able to handle much higher electrical currents than other resistors of the same ohmic value with power ratings in excess of 300 Watts. These high power resistors are moulded or pressed into an aluminium heat sink body with fins attached to increase their overall surface area to promote heat loss. The drawback of this type of resistor is that they are larger in size; cost‘s high and exhibits poor performance at high frequencies.

Typical Specifications:

- Available Range : 0.1Ω to 200KΩ
- Tolerance Range : ±5%
- Wattage Range : 3 W to 50 W
- Operating temperature: -55°C to 275°C
- DC working voltage : up to 500V

Variable Resistors:

They are usually used in electronic circuits to adjust values of currents & voltages. Potentiometers, presets and rheostats are examples of variable resistors.

Rheostat:

These are usually used in high power applications. It is constructed by winding a former with a Nickel-Copper wire in oxidation form. Former is usually 15cm – 30cm long, round shaped, made of ceramic & coated with vitreous enamel. A movable contact can be slided through an iron rod. Threading type terminals are provided for external connections.

Potentiometer:

Another type of variable resistor commonly used is Potentiometers. They are available in the following ranges; 1K, 2.2K, 4.7K, 10K, 22K, 47K, 100K. Power rating of carbon track potentiometer ranges up to 2W. For high power applications wire wound potentiometers are used.

Presets:

These types of variable resistors are used where the variation of resistance is not done frequently. Once the setting is made, it may be undisturbed. These types of resistors have a metallic wiper that can be moved with a screw driver. The tracks on which the wiper moves are carbonized or metalized ceramic.

Capacitors:

A Capacitor is referred to as a condenser or a device one which stores energy in the form of an electrostatic field which produces a potential across its plates. Basically a capacitor consists of two parallel conductive plates that are not connected but are electrically separated either by air or by an insulating material called the Dielectric. On applying a voltage to these plates, current flows charging up the plates with electrons giving one plate a positive charge and the other plate an equal and opposite negative charge. This flow of electrons to the plates is known as the charging current and continues to flow until the voltage across the plates (and hence the capacitor) is equal to the applied voltage VC . .The parallel plate capacitor is the simplest form of capacitor and its capacitance value is fixed by the equal area of the plates and the distance or separation between them. Altering any two of these values alters the value of its capacitance and this forms the basis of operation of the variable capacitors. Unlike other passive devices, there are several characteristics associated with a capacitor which are useful in selecting a capacitor for application & categorizing capacitors.

Working Voltage:

The Working Voltage is the maximum continuous voltage that can be applied to the capacitor without failure during its working life. DC and AC values are usually not then same as the AC value refers to the rms. value. Common working DC voltages are 10V, 16V, 25V, 35V, 63V, 100V, 160V, 250V, 400V and 1000V and are printed onto the body of the capacitor.

Tolerance, (±%):

This specifies how much the capacitor‘s actual values are nearer to the rated capacitance with coloured bands or letters. Capacitor‘s tolerance rating is expressed as a plus-or-minus value either in Picofarads (±pF) for low value capacitors generally less than 10pF or as a percentage (±%) for higher value capacitors generally higher than 10pF. The most common tolerance for capacitors is 5% or 10% but some electrolytic capacitors are rated as high as 20%.

Leakage Current:

The dielectric used inside the capacitor is not a perfect insulator resulting in a very small current flowing or "leaking" through the dielectric when applied to a constant supply voltage. This small current flow in the region of micro amps (μA) is called the Leakage Current. This leakage current is a result of electrons physically making their way through the dielectric medium, around its edges or across the leads. The "leakage current" of a capacitor is sometimes called the "insulation resistance" and can be found using Ohm's law.

Temperature Coefficient:

The Temperature Coefficient of a capacitor is the change in its capacitance with temperature expressed linearly as parts per million per degree centigrade (PPM/°C), or as a percent change over a specified temperature range.

Polarization:

Polarization generally refers to the electrolytic type capacitors regarding to their connection. The majority are polarized types, that is the voltage connected to the capacitor terminals must have the correct polarity, i.e. +ve to +ve and -ve to -ve. Incorrect polarization can cause the oxide layer inside the capacitor to break down resulting in very large currents flowing through the device. The majority of electrolytic capacitors have their -ve terminal clearly marked with a black stripe or black arrows down the side to prevent any incorrect connection.

Equivalent Series Resistance, (ESR):

The Equivalent Series Resistance is the AC impedance of the capacitor when used at high frequencies and includes the resistance of the dielectric, plate and terminal leads. ESR acts like a resistor (less than 0.1Ω) in series with the capacitor and is frequency dependant.

Film Capacitors:

Film Capacitors are the most commonly available type of capacitor, consisting of a relatively large family of capacitors with the difference being in their dielectric properties.

These include polyester (Mylar), polystyrene, polypropylene, polycarbonate, metalized paper, Teflon etc. Film type capacitors are available in capacitance ranges from 5pF to 100uF depending upon the actual type of capacitor and its voltage rating. Film capacitors are generally used for higher power and more precise applications.

Ceramic Capacitors

Ceramic Capacitors or Disc Capacitors as they are generally called are made by coating two sides by a small porcelain or ceramic disc with silver and are then stacked together to make a capacitor. For very low capacitance values a single ceramic disc of about 3-6mm is used. Ceramic capacitors have a high dielectric constant and are available so that relatively high capacitances can be obtained in a small physical size. Ceramic capacitors have values ranging from a few picofarads to one or two microfarads but their voltage ratings are generally quite low.

Ceramic types of capacitors generally have a 3-digit code printed onto their body to identify their capacitance value. For example, 103 would indicate 10 x 103pF which is equivalent to 10,000 pF or0.01μF. Likewise, 104 would indicate 10 x 104pF which is equivalent to 100,000 pF or 0.1μF and so on.

Electrolytic Capacitors:

Electrolytic Capacitors are generally used when very large capacitance values are required. Here instead of using a very thin metallic film layer for one of the electrodes, a semi-liquid electrolyte solution in the form of a jelly or paste is used which serves as the second electrode (usually the cathode). The dielectric is a very thin layer of oxide which is grown electro-chemically in production with the thickness of the film being less than ten microns. This insulating layer is so thin that it is possible to make large value capacitors of a small size. The majority of electrolytic types of capacitors are polarized, that is the voltage applied to the capacitor terminals must be of the correct polarity as an incorrect polarization will break down the insulating oxide layer and permanent damage may result. Electrolytic Capacitors are generally used in DC power supply circuits to help reduce the ripple voltage or for coupling and decoupling applications. Electrolytic's generally come in two basic forms; Aluminium Electrolytic and Tantalum Electrolytic capacitors.

Aluminium Electrolytic Capacitors:

There are basically two types of Aluminium Electrolytic Capacitor, the plain foil type and the etched foil type. The thickness of the aluminium oxide film and high breakdown voltage give these capacitors very high capacitance values for their size. The etched foil type differs from the plain foil type in that the aluminium oxide on the anode and cathode foils has been chemically etched to increase its surface area and permittivity. This gives a smaller sized capacitor than a plain foil type of equivalent value. Despite, this type can't withstand high AC currents when compared to the plain type. Also their tolerance range is quite large up to 20%. Etched foil electrolytic's are best used in coupling, DC blocking and by-pass circuits while plain foil types are better suited as smoothing capacitors in power supplies. Typical values of capacitance range from 1uF to 47000uF. Aluminium Electrolytic's are "polarized" devices so reversing the applied voltage on the leads will cause the insulating layer within the capacitor to be destroyed along with the capacitor, "so be aware".

Tantalum Electrolytic Capacitors:

Tantalum Electrolytic Capacitors or Tantalum Beads, are available in both wet (foil) and dry (solid) electrolytic types with the dry (solid tantalum being the most common). Solid tantalums use manganese dioxide as their second terminal and are physically smaller than the equivalent aluminium capacitors.

The dielectric properties of tantalum oxide is also much better than those of aluminium oxide This is because it gives lower leakage currents and better capacitance stability which makes them suitable for timing applications. Also tantalum capacitors although polarized, can tolerate when connected to a reverse voltage much more easily than the Aluminium types but are rated at much lower working voltages. Typical values of capacitance range from 47nF to 470μF.

Inductors:

The Inductor is another passive type electrical component designed to take advantage of this relationship (a wound coil is to use this magnetic flux to oppose or resist any changes in electrical current flowing through it) by producing a much stronger magnetic field than one that would be produced by a simple coil. Inductors are formed with wire tightly wrapped around a solid central core which can be either a straight cylindrical rod or a continuous loop or ring to concentrate their magnetic flux. The schematic symbol for a inductor is that of a coil of wire so therefore, a coil of wire can also be called an Inductor. Based on the type of core used they are categorized as air core inductor, iron core inductor, ferrite core inductor & powder core inductors. Variable inductors, transformers are a few categories of inductors that we commonly use.

Transformer:

Its a device that works on the principle of mutual induction that is, it has 2 or more coils which are used to transfer electrical energy from one circuit to another at different voltages without changing the frequency. The most commonly used transformer is the power transformer. A power transformer is used to step up / step down the supply voltage & current. In step up, the number of turns in primary winding will be less than that in the secondary winding while in a step down transformer, the number of turns in the secondary will be less than that of primary winding. So a step up transformer is used for converting low voltage to high voltage and a step down transformer is used for converting a high voltage to a low voltage. Transformers are selected & categorized based on certain specifications such as;

Voltage Rating:

It specifies the primary and secondary voltage of the transformer. It depends on the turn’s ratio of the windings and is usually expressed in Volts (V).

Current Rating:

It specifies the maximum current that the transformer winding can pass through to the load without any damage for the winding. It is expressed in Amperes (A).

Power Rating:

It specifies the maximum amount of power that can be delivered by the transformer continuously. It is usually expressed in Volts-Ampere (VA).

Frequency Range:

It specifies the frequency range in which the transformer operates without any failure.

ACTIVE COMPONENTS

Semiconductor Diodes:

The term semiconductor diode refers to a two electrodes/ terminal device. A semiconductor diode is a one-way device, offering a low resistance when forward biased, and behaving almost as an open switch when reverse biased. A normal pn-junction diode consists of a p-type & n-type semiconductors sandwiched together. The p-side of the diode is always positive & is termed as anode while the n-side of the diode is always negative and termed as cathode. The circuit diagram of the diode is an arrowhead and bar where the arrowhead indicates the conventional direction of current flow under forward-biased.

They are mainly manufactured of semiconductors such as Silicon & Germanium. In case of Si, it can be seen that forward current(IF) remains very low until the forward voltage drop (VF) exceeds the barrier potential (VF≈0.7V). At VF greater than 0.7V, IF increases almost linearly. In case of Ge, VF changes to 0.3V. Since, the reverse currents are very much smaller than the forward current; the reverse characteristics are plotted on expanded current scales. For Si diode, IR is normally less than 100nA, and its almost independent of the reverse-bias voltage. For Ge diodes it falls in the micro-ampere range. Since, IR is the current due to minority charge carriers; it increases with increasing reverse-bias voltage. Also, the reverse breakdown voltage of Ge diode is substantially lower than that of Si diodes.

Taking into account the lower forward voltage drop of Ge diode they has a distinct advantage but, the lower reverse current and higher reverse breakdown voltage of Si diodes makes more preferable in applications.

Some Important Diode Parameters:

Peak Reverse Voltage (VR /VRRM) - Max. reverse voltage that can be applied across the diode.

Steady State Forward current (IO/IF) – Max. current that can be passed continuously through the diode.

Non-repetitive peak surge current (IFSM) – The maximum current that can be allowed to flow through the diode when it is switched ON first.

Repetitive current (IFRM) – Peak current that can be repeated over again & again during the forward biased operation of a diode Static forward voltage drop (VF) – Max. forward voltage drop for a given forward current & device temperature.

Continuous power dissipation (PD) – The max. power that the device can safely dissipate to the surrounding without the device getting damaged. 1N4001 to 1N4007, OA79, BY127, etc are some of the diodes that are popular in the market. Signal diodes, Rectifier diodes, LED‘s, Zener diodes, Photo diodes, etc constitute the various categories of diodes.

Rectifier Diodes:

These diodes are used in rectification processes. These diodes are also called as low-power diodes. They are usually capable of passing a maximum forward current of 1A approx. They can also survive a reverse bias up to 500V and their reverse current is normally less than 1μA at 25°C. 1N4001 to 1N4007 Silicon diodes is an example of rectifier diodes.

They may be only posses a dimension of 0.3cm long & the cathode can be identified by a coloured band. These are generally intended for low-frequency applications.

Signal Diodes:

The Signal Diode is a small non-linear semiconductor devices generally used in electronic circuits, where small currents or high frequencies are involved such as in radio, television and digital logic circuits or where a low value of capacitance is required between the terminals of the device. Signal diodes which are also sometimes known by their older name Point Contact or Glass Diode. They are physically very small in size and control small currents. Generally, a signal diode is encapsulated in glass to protect it and they generally have a red or black band at one end of their body to help identify which end is its Cathode terminal. In case of Ge signal diodes, they have a low reverse resistance value giving a lower forward volt drop across the junction, typically only about 0.2-0.3v, but have a higher forward resistance value because of their small junction area. While for Si signal diodes they have a very high value of reverse resistance and give a forward volt drop of about 0.6- 0.7v across the junction. They have fairly low values of forward resistance giving them high peak values of forward current and reverse voltage. The most widely used of all the glass encapsulated signal diode is 1N4148 Signal diode &OA79 Ge signal diode.

Zener Diodes:

Zener Diodes or "Breakdown Diodes" as they are sometimes called, are basically the same as the standard junction diode but are specially made to have a low predetermined Reverse Breakdown Voltage, called the "Zener Voltage" (VZ). In the forward direction it behaves just like a normal diode passing current, but when the reverse voltage applied to it exceeds the selected reverse breakdown voltage, reverse breakdown occurs in the diode & the current through the diode increases to the maximum circuit value, which is usually limited by a series resistor.

There are mainly two mechanisms that results in this reverse breakdown in the reverse biased condition namely; Zener breakdown (on applying a high intensity electric field across a narrow depletion region, the electrons break away from their atoms thus converting the insulating depletion to conductor region that is, ionization by electric field)and Avalanche breakdown (if the depletion region is too wide, then in the presence of sufficient reverse bias voltage the electrons in the reverse saturation current collides with the electrons in the depletion region and thereby cause breakdown to occur that is, ionization by collision). Usually, Zener breakdown occurs at reverse bias less than 5V and avalanche breakdown occurs at reverse voltage level above 5V.

Transistors

A bipolar junction transistor (BJT) is simply a sandwich of one type of semiconductor material (n/p type) between two layers of the opposite type. Hence, there are basically two configurations of BJT namely; npn & pnptransistors. A small current at the central region terminal controls the much larger total current flow through the device. Hence, a transistor can be used for current amplification & voltage amplification.

From the above description, it is clear that a BJT is a three terminal device that is, the centre layer is known as base (B) and one of the outer layers is referred as emitter (E) and the other layer as collector (C). BC107, BF195, BC148, SL100, SK100, 2N3055 are some of commonly used bipolar transistors. The symbolic representations are shown below;

Field Effect Transistors

A field effect transistor (FET) is a unipolar, voltage controlled device which can be used for amplifiers & switching circuits, similar to a bipolar transistor. Unlike a BJT, a FET doesn‘t require an input current virtually which results in an extremely high input resistance; the most prominent advantage of FET over a BJT. There are two categories of FET namely; Junction FET (JFET) &Metal Oxide Semiconductor FET (MOSFET). These are further subdivided as p-channel & n-channel devices. In general, a FET has 4 terminals namely; Source(S),Drain(D), Gate(G) and Shield/Substrate(S). BFW10 & BFW11 are the popularly used n-channel JFETs.

Unijunction Transistors:

The unijunction transistor (UJT) consists of a bar of lightly doped n-type silicon with a block of p-type material on one side. Ohmic contacts are made at the opposite ends of the n-type bar, one of the terminals is termed as base1 (B1) and base2 (B2) of the transistor and the p-type rod is termed as emitter (E). Referring to the equivalent circuit, the resistance of the n-type Si bar is represented by two resistors namely, rB1and rB2. The summation of these two resistors provides the inter base resistance (RBB) of UJT. The diode (D1) represents the pn-junction between p-type and n-type semiconductor of the UJT. The prominent feature considered in application level is the negative resistance behaviour which is used in designing oscillators. They also play a key role in designing the firing/ triggering circuits for SCR‘s, in sweep wave generation, etc. 2N2646 is one of the most commonly used UJT.

Cables:

Solid wire and cable are the oldest forms of electronic transmission media. This lesson covers three basic types, still in use in building networks, coaxial, unshielded twisted-pair, and fiber optic. Thin coaxial cable has a core of copper wire and is primarily used for peer-to-peer LANs due to its low bandwidth and problems with EMI (Electro Magnetic Interference). Unshielded twisted-pair cable has twisted pairs of wires as the core and is divided into five categories, with category 5 used most commonly for building LANs. Fiber optic cable has a core made of glass and uses light pulses to transmit information across a network.

Thin Coaxial Cable:

Early networks used coaxial cable to connect computers together. Many LANs were built with coaxial cable. It is often referred to as Thin Net. Coaxial cable has, A core of copper wire surrounded by a layer of plastic.

A layer of metal mesh.

An outer protective plastic insulation sheath.

Unshielded Twisted-Pair Cable:

Unshielded twisted-pair cable is separated into five categories designated by the TIA/EIA 568-A standard.

- Category 1 is telephone cable.
- Category 2 was used for token ring networks and is not recommended for Ethernet networks.
- Categories 3 and 4 can be used with Ethernet networks, but suffer more from EMI than category 5. Category 3 cables typically have two twists per foot.
- Category 4 cables have more twists per foot, but less than Category 5cables. The twisting of the wires in cables is to help prevent EMI (Electro-Magnetic Interference).
- Category 5 cable is primarily used in LANs. The most typical connector used with UTP is a RJ-45, which resembles a large telephone connectorRJ-11). This cable has a very high twist rate per foot.

Fiber-Optic Cable:

Fiber optic cable uses light pulses rather than electrical signals to transmitting formation across a network. The cable may be used over many miles because there is no electrical EMI (Electro-Magnetic Interference) and the bandwidth is very high. Fiber optic cable is usually used for the backbone of a network. Since glass and plastic cores can be cracked or broken, installation requires care. Special monitoring equipment is required to locate a break in the fiber optic cable.

Connectors:

An electrical connector is an electro-mechanical device for joining electrical circuits as an interface using a mechanical assembly. Connectors consist of plugs (male-ended) and jacks (female-ended). The connection may be temporary, as for portable equipment, require a tool for assembly and removal, or serve as a permanent electrical joint between two wires or devices. An adapter can be used to effectively bring together dissimilar connectors. There are hundreds of types of electrical connectors. Connectors may join two lengths of flexible copper wire or cable, or connect a wire or cable to an electrical terminal

Electrical connectors are characterized by their pin out and physical construction, size, contact resistance, insulation between pins, ruggedness and resistance to vibration, resistance to entry of water or other contaminants, resistance to pressure, reliability, lifetime (number of connect/disconnect operations before failure), and ease of connecting and disconnecting.

They may be keyed to prevent insertion in the wrong orientation, connecting the wrong pins to each other, and have locking mechanisms to ensure that they are fully inserted and cannot work loose or fall out. Some connectors are designed such that certain pins make contact before others when inserted, and break first on disconnection; this protects circuits typically in connectors that apply power, e.g. connecting safety ground first, and sequencing connections properly in hot swapping applications. It is usually desirable for a connector to be easy to identify visually, rapid to assemble, require only simple tooling, and be inexpensive. In some cases an equipment manufacturer might choose a connector specifically because it is not compatible with those from other sources, allowing control of what may be connected. No single connector has all the ideal properties; the proliferation of types is a reflection of differing requirements. Fretting is a common failure mode in electrical connectors that have not been specifically designed to prevent it.

Keying:

Many connectors are keyed, with some mechanical component which prevents mating except with a correctly oriented matching connector. This can be used to preventing correct or damaging interconnections, either preventing pins from being damaged by being jammed in at the wrong angle or fitting into imperfectly fitting plugs, or to prevent damaging connections, such as plugging an audio cable into a power outlet. For instance, XLR connectors have a notch to ensure proper orientation, while Mini Din plugs have a plastic projection, which fits into a corresponding hole in the socket and prevent different connectors from being pushed together (they also have a notched metal skirt to provide secondary keying).

Plug and socket connectors:

Plug and socket connectors are usually made up of a male plug (typically pin contacts) and a female receptacle (typically socket contacts), although hermaphroditic connectors exist, such as the original IBM token ring LAN connector. Plugs generally have one or more pins or prongs that are inserted into openings in the mating socket. The connection between the mating metal parts must be sufficiently tight to make a good electrical connection and complete the circuit. When working with multi-pin connectors, it is helpful to have a pinout diagram to identify the wire or circuit node connected to each pin.

Component and device connectors:

High-power transistor switch module with large screw connectors and small crimped-on "Fast-on" connectors. Electrical and electronic components and devices sometimes have plug and socket connectors or terminal blocks, but individual screw terminals and fast-on or quick-disconnect terminals are more common. Small components have bare lead wires for soldering.

Blade connector:

A blade connector is a type of single wire connection using a flat conductive blade which is inserted into a blade receptacle. Usually both blade connector and blade receptacle have wires attached to them either through of the wire to the blade or crimping of the blade to the wire. In some cases the blade is an integral manufactured part of a component (such as a switch or a speaker unit), and a blade receptacle is pushed onto the blade to form a connection.

A common type of blade connector is the "Faston terminal". While Faston is a trademark of TE Connectivity (formerly Tyco Electronics), it has come into common usage. Faston connectors come in male and female types. They have been commonly used since the 1970s.

Ring and spade terminals:

The connectors in the top row of the image are known as ring terminals and spade terminals (sometimes called fork or split ring terminals). Electrical contact is made by the flat surface of the ring or spade, while mechanically they are attached by passing a screw or bolt through them. The spade terminal form factor facilitates connections since the screw or bolt can be left partially screwed in as the spade terminal is removed or attached. Their sizes can be determined by the size of the conducting wire AWG and the screw/bolt diameter size designation.

P8C connector:

8P8C is short for "eight positions, eight conductors", and so an 8P8C modular connector (plug or jack) is a modular connector with eight positions, all containing conductors. The connector is probably most famous for its use in Ethernet and widely used on CAT5 cables.

The 8P8C modular plugs and jacks look very similar to the plugs and jacks used for FCC's registered jack RJ45 variants, although the specified RJ45 socket is not compatible with 8P8C modular plug connectors. It neither uses all eight conductors (but only two of them for wires plus two for connecting a programming resistor) nor does it fit into 8P8C because the true RJ45 is "keyed"

D-subminiature connectors:

The D-subminiature electrical connector is commonly used for the RS-232 serial port on modems and IBM compatible computers. The D-subminiature connector is used in many different applications, for computers, telecommunications, and test and measurement instruments. A few examples are monitors (MGA, CGA, EGA), the Commodore 64, MSX, Apple II, Amiga, and Atari joysticks and mice, and game consoles such as Atari and Sega.

Another variant of D-subminiature are the Positronic D-subminiature connector which have PosiBand closed entry contact option, solid machined contacts, thermocouple contact options, crimp and PCB mount.And- the Positronic Combo D-subminiature which have Large Surface Area (LSA) contact system that is for low contact resistance and saves energy, and sequential mating options.

USB connectors:

The Universal Serial Bus is a serial bus standard to interface devices, founded in 1996. It is currently widely used among PCs, Apple Macintosh and many other devices. There are several types of USB connectors, and some have been added as the specification has progressed. The most commonly used is the (male) series "A" plug on peripherals, when the cable is fixed to the peripheral. If there is no cable fixed to the peripheral, the peripheral always needs to have a USB "B" socket. In this case a USB "A" plug to a USB "B" plug cable would be needed. USB "A" sockets are always used on the host PC and the USB "B" sockets on the peripherals. It is a 4-pin connector, surrounded by a shield. There are several other connectors in use, the mini-A, mini- B and mini-AB plug and socket (added in the On-The-Go Supplement to the USB 2.0 Specification).

Power connectors:

Power connectors must protect people from accidental contact with energized conductors. Power connectors often include a safety ground connection as well as the power conductors. In larger sizes, these connectors must also safely contain any arc produced when an energized circuit is disconnected or may require interlocking to prevent opening a live circuit.

Socket, is the general term, in British English, but there are numerous common alternatives for household connectors, including power point, plug socket, wall socket, and wall plug. Receptacle and outlet are common in American English, for household connectors, sometimes with qualifiers such as wall outlet, electrical outlet and electrical receptacle.

Radio frequency connectors:

Connectors used at radio frequencies must not change the impedance of the transmission line of which they are part, otherwise signal reflection and losses will result. A radio-frequency connector must not allow external signals into the circuit, and must prevent leakage of energy out of the circuit. At lower radio frequencies simple connectors can be used with success, but as the radio frequency increases, transmission line effects become more important, with small impedance variations from connectors causing the signal to reflect from the connector, rather than to pass through. At UHF and above, silver-plating of connectors is common to reduce losses. Common types of RF connectors are used for television receivers, two-way radio, certain Wi-Fi devices with removable antennas, and industrial or scientific measuring instruments using radio frequencies.

Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid state relays. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

Fuse:

In electronics and electrical engineering, a fuse is a type of low resistance resistor that acts as a sacrificial device to provide over current protection, of either the load or source circuit. It‘s essential component is a metal wire or strip that melts when too much current flows through it, interrupting the circuit that it connects. Short circuits, overloading, mismatched loads, or device failure are the prime reasons for excessive current. Fuses are an alternative to circuit breakers. Electronic symbols for a fuse.

Switch:

A switch responds to an external force to mechanically change an electric signal. Switches are used to turn electric circuits ON and OFF and to switch electric circuits. There are many different types of switches. Based on their size, robustness, environmental resistance and other characteristics, they are divided into switches for industrial equipment and switches for consumer and commercial devices.

Display

A display device (commonly called a display or screen) is an output device for presentation of information in visual or tactile form (the latter used for example in tactile electronic displays for blind people). When the input information is supplied as an electrical signal, the display is called an electronic display.

Segment Display:

Some displays can show only digits or alphanumeric characters. They are called segment displays, because they are composed of several segments that switch on and off to give appearance of desired glyph. The segments are usually single LEDs or liquid crystals. They are mostly used in digital watches and pocket calculators.

Heat Sink:

In electronic systems, a heat sink is a passive heat exchanger that cools a device by dissipating heat into the surrounding medium. In computers, heat sinks are used to cool central processing units or graphics processors. Heat sinks are used with high-power semiconductor devices such as power transistors and optoelectronics such as lasers and light emitting diodes (LEDs), where the heat dissipation ability of the basic device is insufficient to moderate its temperature.

EXPERIMENT: 02

AIM OF THE EXPERIMENT

To study the V-I characteristics of P-N junction diode and amplifier; to calculate DC and amplifier; AC resistance.

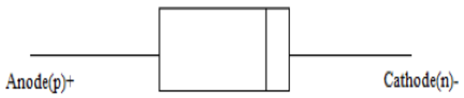
APPARATUS REQUIRED

SL. NO.	NAME 0F APPARATUS	SPECIFICATION	QUANTITY
1	P-N Junction Diode Trainer Kit		
2	Connecting Wires		

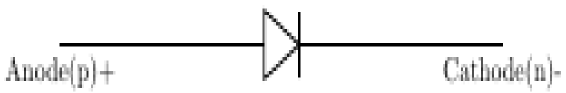
THEORY

Structure of P-N junction diode:

The diode is a device formed from a junction of n-type and p-type semiconductor material. The lead connected to the p-type material is called the anode and the lead connected to the n-type material is the cathode.



(a)



(b)

Fig 2.1: (a) Schematic Diagram (b) Symbolic Presentation of P-N junction diode

Function of P-N junction diode

Forward Bias:

The positive terminal of battery is connected to the P side(anode) and the negative terminal of battery is connected to the N side(cathode) of a diode, the holes in the p-type region and the electrons in the n-type region are pushed toward the junction and start to neutralize the depletion zone, reducing its width. The positive potential applied to the p-type material repels the holes, while the negative potential applied to the n-type material repels the electrons. The change in potential between the p side and the n side decreases or switches sign. With increasing forward-bias voltage, the depletion zone eventually becomes thin enough that the zone's electric field cannot counteract charge carrier motion across the p–n junction, which as a consequence reduces electrical resistance. The electrons that cross the p–n junction into the p-type material (or holes that cross into the n-type material) will diffuse into the nearby neutral region. The amount of minority diffusion in the near-neutral zones determines the amount of current that may flow through the diode.

Reverse Bias:

The positive terminal of battery is connected to the N side (cathode) and the negative terminal of battery is connected to the P side(anode) of a diode. Therefore, very little current will flow until the diode breaks down.

The 'holes' in the p-type material are pulled away from the junction, leaving behind charged ions and causing the width of the depletion region to increase. Likewise, because the n-type region is connected to the positive terminal, the electrons will also be pulled away from the junction, with similar effect. This increases the voltage barrier causing a high resistance to the flow of charge carriers, thus allowing minimal electric current to cross the p–n junction. The increase in resistance of the p–n junction results in the junction behaving as an insulator. The strength of the depletion zone electric field increases as the reverse-bias voltage increases. Once the electric field intensity increases beyond a critical level, the p–n junction depletion zone breaks down and current begins to flow, usually by either the Zener or the avalanche breakdown processes. Both of these breakdown processes are non-destructive and are reversible, as long as the amount of current flowing does not reach levels that cause the semiconductor material to overheat and cause thermal damage.

MODEL GRAPH

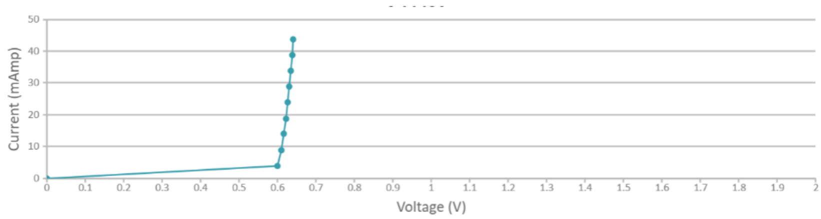


Fig 2.2: V-I Characteristics of P-N junction diode in forward bias

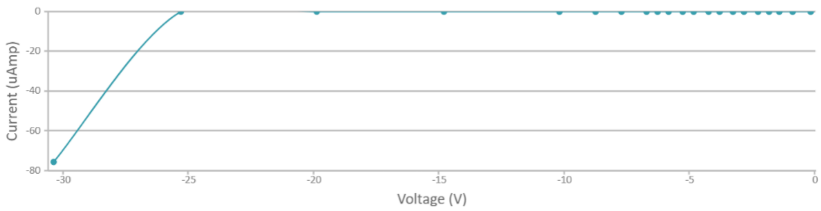


Fig 2.3: V-I Characteristics of P-N junction diode in reverse bias

CIRCUIT DIAGRAM:

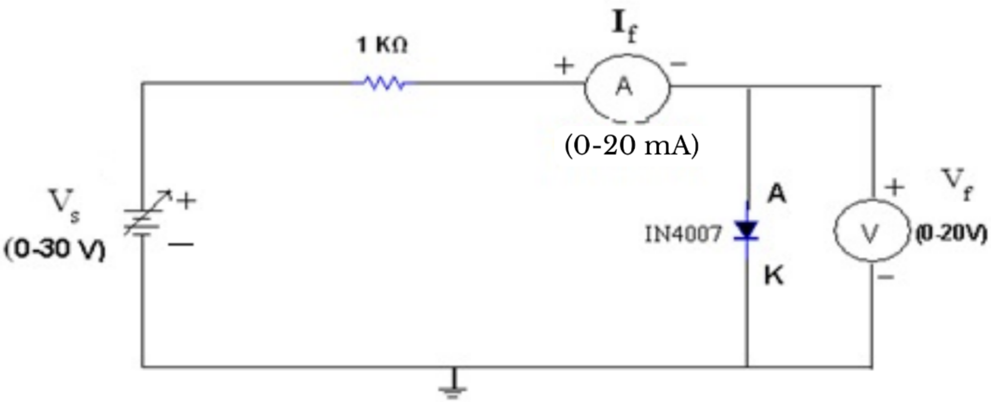


Fig 2.4: Circuit Diagram of P-N Junction Diode for Forward Bias

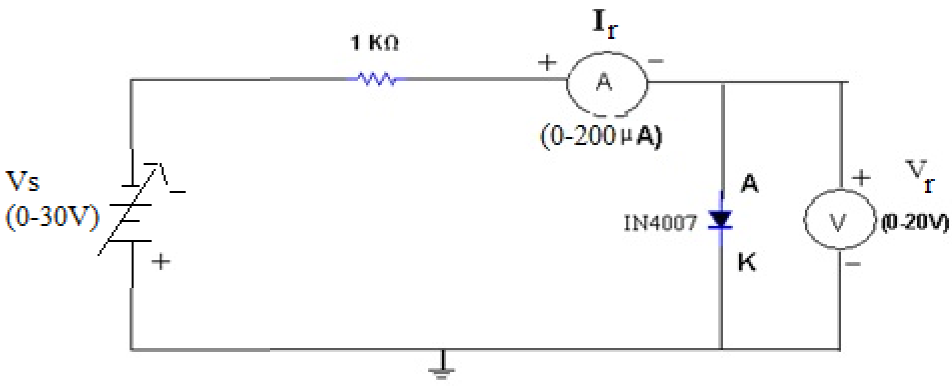


Fig 2.5: Circuit Diagram of P-N Junction Diode for Reverse Bias

PROCEDURE

For Forward Biased Condition:

- Connect the circuit as shown in fig 2.4 using silicon PN Junction diode.
- Vary Vf gradually in steps of 0.1 volts up to 5volts and note down the corresponding readings of If.
- Step size is not fixed because of non-linear curve and vary the X-axis variable (i.e., if output variation is more, decrease input step size and vice versa).
- Tabulate different forward currents obtained for different forward voltages.
- For Reverse Biased Condition:
- Connect the circuit as shown in fig 2.5 using silicon PN Junction diode.
- Vary Vr gradually in steps of 0.5 volts up to 8 volts and note down the corresponding readings of Ir.
- Tabulate different reverse currents obtained for different reverse voltages. (Ir = VR / R, where VR is the voltage across 10KΩ Resistor).

OBSERVATION

Table2.1: In Forward Biased Condition

SL. NO.	Forward Voltage Vf (volts)	Forward Current If(mA)

Table2.2: In Reverse Biased Condition

SL. NO.	Reverse Voltage VR (volts)	Forward Current IR(mA)

CALCULATION

For Forward Biased Condition:

- Static forward resistance, $R_{dc} = \frac{V_f}{I_f}\ \Omega$
- Dynamic forward resistance, $r_{ac} = \frac{\Delta V_f}{\Delta I_f}\ \Omega$
- For Reverse Biased Condition:
- Static forward resistance, $R_{DC} = \frac{V_r}{I_r}\ \Omega$
- Dynamic forward resistance, $r_{ac} = \frac{\Delta V_r}{\Delta I_r}\ \Omega$

RESULT

Cut in voltage = _____ V

Static forward resistance = _____ Ω

Dynamic forward resistance = _____ Ω

DISCUSSION

1. How depletion region is formed in the PN junction?
2. What are trivalent and pentavalent impurities?
3. What is cut-in or knee voltage? Specify its value in case of Ge or Si?
4. What is maximum forward current and maximum reverse voltage? What is it required?
5. What is leakage current?

EXPERIMENT -3

AIM OF THE EXPERIMENT

Construction of half wave rectifier and full wave rectifier circuit and study of their output waveforms by CRO and calculation of efficiency and ripple factor .

APPARATUS REQUIRED

SL.NO	ITEM TO BE USED
1	AC step down transformer
2	Resistance
3	Diodes
4	Voltmeter and Ammeter
5	CRO
6	Filters
7	Bread band

THEORY

Half Wave Rectifier

A simple Half Wave Rectifier is nothing more than a single pn junction diode connected in series to the load resistor. As you know a diode is to electric current like a one-way valve is to water, it allows electric current to flow in only one direction. This property of the diode is very useful in creating simple rectifiers which are used to convert AC to DC. Rectification is the most important application of a PN junction diode. The process of rectification is converting alternating current (AC) to direct current (DC). The operation of a half wave rectifier is pretty simple. From the theory part, you should know that a pn junction diode conducts current only in 1 direction. In other words, a pn junction diode conducts current only when it is forward biased. The same principle is made use of in a half wave rectifier to convert AC to DC. The input we give here is an alternating current. This input voltage is stepped down using a transformer. The reduced voltage is fed to the diode 'D' and load resistance RL. During the positive half cycles of the input wave, the diode 'D' will be forward biased and during the negative half cycles of input wave, the diode 'D' will be reverse biased. We take the output across load resistor RL. Since the diode passes current only during one-half cycle of the input wave, we get an output as shown in the diagram. The output is positive and significant during the positive half cycles of the input wave. At the same time output is zero or insignificant during negative half cycles of the input wave. This is called ***half wave rectification.***

Efficiency of half wave rectification is = n = 0.406 =40.6%

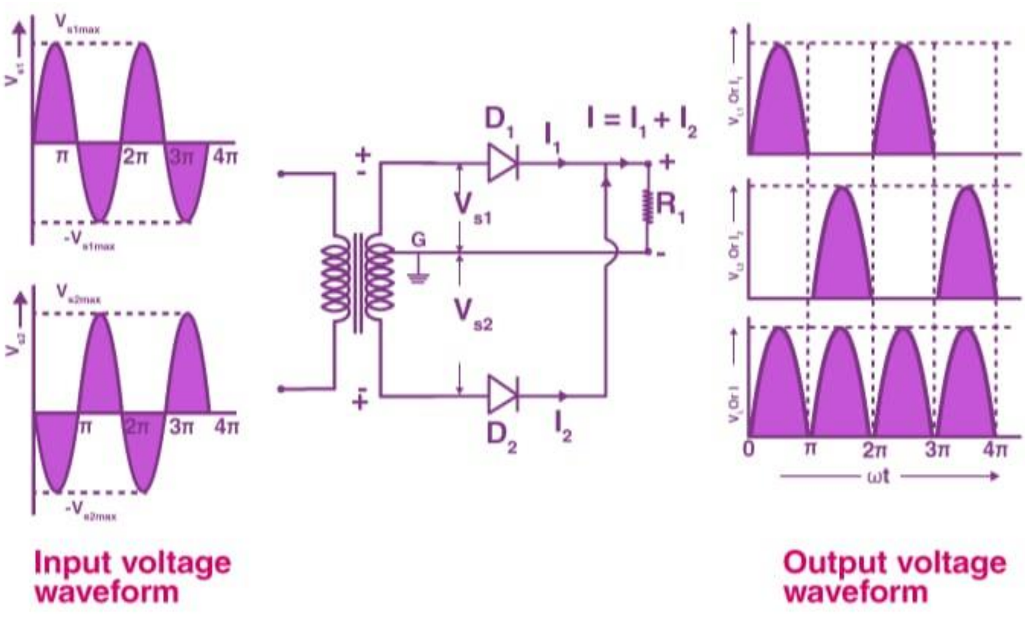
RIPPLE FACTOR

The ac components present in the output of a rectifier is called Ripple .It is measure of AC components present in the output of the rectifier.

$$RIPPLE\ FACTOR = \frac{RMS\ value\ of\ ac\ components}{RMS\ value\ of\ DC\ componnets}$$

FULL WAVE RECTIFIER

Significant power is lost while using a half-wave rectifier and is not feasible for applications that need a smooth and steady supply. For a more smooth and steady supply, we use the full wave rectifiers. A full wave rectifier is defined as a rectifier that converts the complete cycle of alternating current into pulsating DC. The input AC supplied to the full wave rectifier is very high. The step-down transformer in the rectifier circuit converts the high voltage AC into low voltage AC. The anode of the centre tapped diodes is connected to the transformer's secondary winding and connected to the load resistor. During the positive half cycle of the alternating current, the top half of the secondary winding becomes positive while the second half of the secondary winding becomes negative.



BRIDGE RECTIFIER

A bridge rectifier is a type of full wave rectifier which uses four or more diodes in a bridge circuit configuration to efficiently convert the Alternating Current (AC) into Direct Current (DC). When input AC signal is applied across the bridge rectifier, during the positive half cycle diodes D_1 and D_3 are forward biased and allows electric current while the diodes D_2 and D_4 are reverse biased and blocks electric current. On the other hand, during the negative half cycle diodes D_2 and D_4 are forward biased and allows electric current while diodes D_1 and D_3 are reverse biased and blocks electric current.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative. This causes the diodes D_1 and D_3 forward biased and at the same time, it causes the diodes D_2 and D_4 reverse biased. The current flow direction during the positive half cycle is shown in the figure A (I.e. A to D to C to B).

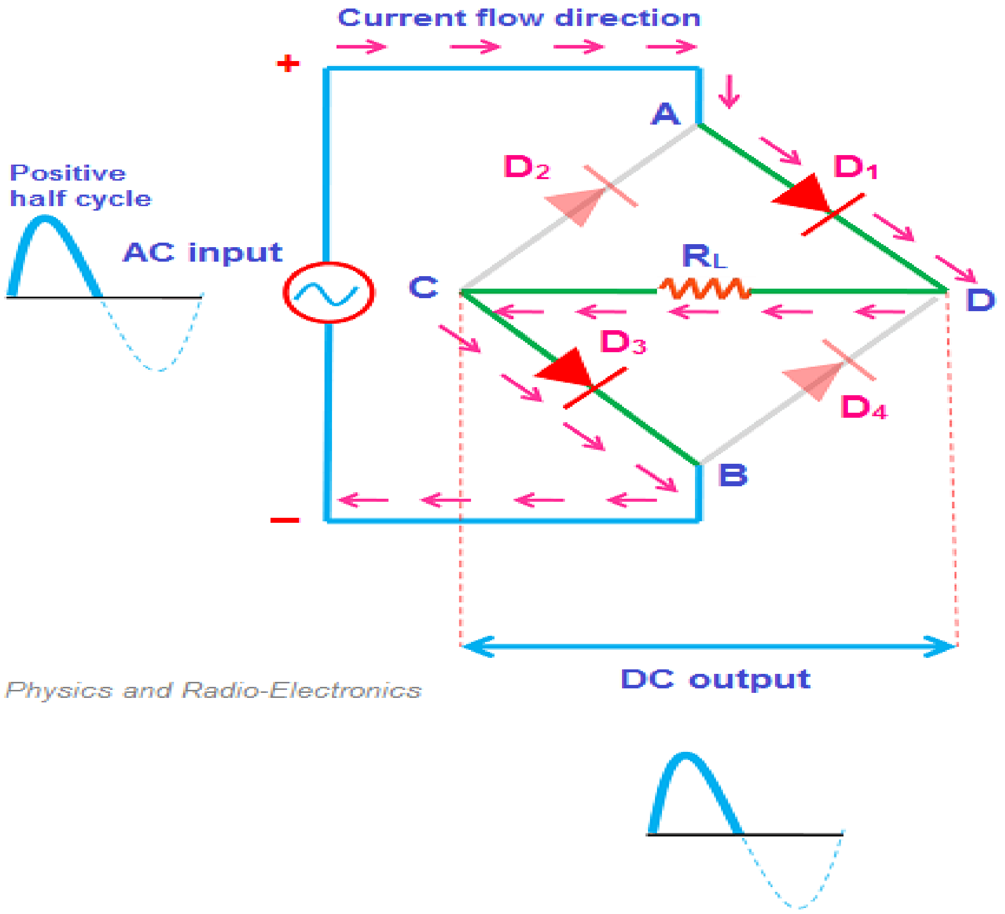


Fig A: Bridge rectifier during positive half cycle

During the negative half cycle, the terminal B becomes positive while the terminal A becomes negative. This causes the diodes D_2 and D_4 forward biased and at the same time, it causes the diodes D_1 and D_3 reverse biased.

The current flow direction during negative half cycle .

PROCEDURE

Half wave rectifier

- A 20v DC voltmeter and 150mA DC current meter is connected in the space provided on front panel.
- A Ac millivoltmeter / CRO across output is connected to measure the ripple directly.
- Load is connected in circuit for measuring DC output current
- The instrument is switched ON/OFF using toggle switch provided on the front panel .
- Observations ,DC output voltage ,DC current and AC ripples on the meters are noted.
- The toggles switches S1 is switched ON to connect the capacitor in the circuit again the DC output voltage DC current and AC ripples are checked
- For the different values of load resistance the experiment was repeated

Full wave rectifier

- The circuit is connected as soon in
- A 20 Volt disease voltmeter and 15 MA DC current metre is connected in the space
- Provided on front panel
- A Ac millivoltmeter /CRO across output is connected to measure the ripple directly
- Load (RL) is connected in circuit for measuring DC output current
- The instrument is switched on /off using toggle switch provided on the front panel
- Observations that is DC output voltage DC current and ac ripples on the respective metres are noted
- The toggle switch s1 is switched on to connect the capacitor c1 in the circuit .again the dc output voltage DC current and AC ripples are checked
- For different AC ripples different values of load resistance the experiment is being repeated

Bridge rectifier

- Connect the circuit as per circuit diagram
- A 20v DC voltmeter and 150 mA DC current meter is connected in the space provided on front panel
- A AC Mini voltmeter /CRO across the output is connected to measure the ripple directly
- Load is connected in circuit for measuring dc output current
- The instrument is switched on/off using toggle switch provided on the front panel
- Observations that is DC output voltage DC current and AC ripples on tier respective meters are noted
- The toggle switch s1 is switched on to connect the capacitor c1 in the circuit , Again the DC output voltage DC current and AC ripples are checked

  For different AC ripples different values of load resistance the experiment is being repeated

OBSERVATIONS

Full wave rectifier

- Observation of DC voltage and DC current with and without filter

Table 3.1: Without filter

SL.NO	R_L	DC voltage	DC current (mA)	AC ripple

Table 3.2: With filter

SL.NO	R_L	DC voltage	DC current (mA)	AC ripple

Table 3.3: Efficiency

Load resistance	Efficiency

Table 3.4: Ripple factor

SL no	R_L	DC voltage	AC ripplevoltage	Ripple factor

Half wave rectifier

- Observation of DC voltage and DC current with and without filter

Table 3.5: Without filter

SL.No	R_L	DC voltage	DC current (mA)	AC ripple

Table 3.6: With filter

SL.No	R_L	DC voltage	DC current (mA)	AC ripple

Table 3.7: Efficiency

Load resistance	Efficiency

Table 3.8: Ripple factor

SL No	R_L	DC voltage	AC ripple voltage	Ripple factor

RESULT

From the above experience we calculated dc voltage, AC ripple voltage ,Efficiency and ripple factor of full wave and half wave rectifier with and without filter.

EXPERIMENT: 04(A)

AIM OF THE EXPERIMENT

Construction of positive, negative clipper circuits and amp; study of their output waveforms by CRO.

APPARATUS REQUIRED

SL. NO.	NAME 0F APPARATUS	SPECIFICATION	QUANTITY
1	1N 4007 diodes		
2	Resistor-10K		
3	TRPS		
4	Function Generator		
5	Bread board		
6	CRO with CRO probes.		
7	Connecting wire		

THEORY

Clippers are used to select a part of signal waveform above or below a reference voltage for transmission.

Negative Clipper:

For Vi < VR +Vr, the diode D is OFF, since it is reverse biased and hence does not contact. Since no current flows, there is no voltage drop across R.

Vo = Vi for Vi < VR + Vr Where Vr is Cut-in voltage of the diode. For Vi > VR + Vr, the diode D is ON, since it is forward biased and the potential barrier is overcome Vo = VR+ Vr

Transfer characteristic Equation:

Vo= Vi for Vi < VR + Vr

Vo= VR + Vr for Vi > VR + Vr

Positive Clipper:

When Vi > VR + Vr the diode is forward biased and hence it conducts since it is ON it is short circuited. It is obvious that Vo= VR + Vr Whatever the comment. When Vi < VR + Vr the diode is reverse biased and hence it is OFF. It acts as an open Circuit. Vo= Vi

Transfer Characteristic Equation:

Vo= Vi for Vi < VR + Vr; Vo= VR + Vr for Vi > VR + Vr

CIRCUIT DIAGRAM:

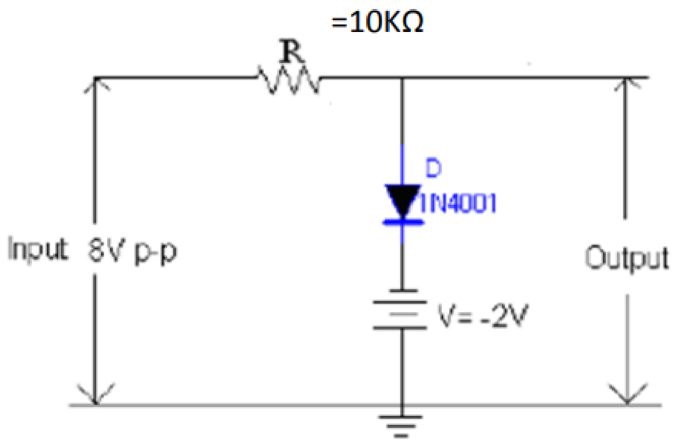


Fig. 4.1: Negative Clipper

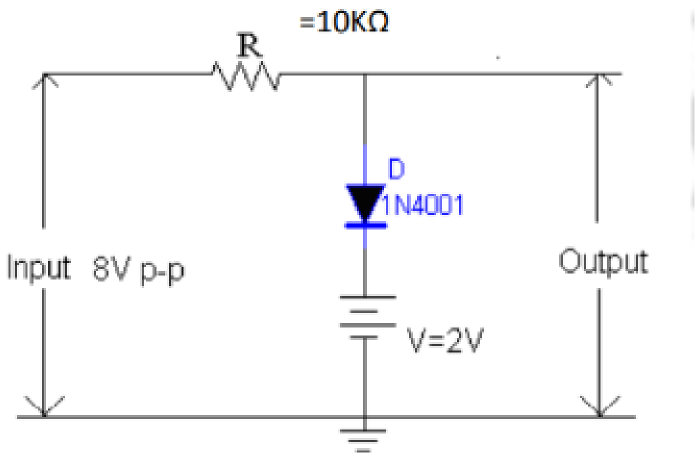


Fig. 4.2: Positive Clipper

PROCEDURE

- Connections are made as per the circuit diagram.
- For the positive clipper the diode is connected along with reference voltage as shown by applying the input and the output is observed on the C.R.O.
- For the negative clipper the directions of diode and the reference voltage are reversed and by giving the input, the output is observed on the C.R.O.
- A sinusoidal input 10V (p-p) 1KHZ is given to positive clipper, negative clipper and slicer circuit and corresponding output is observed.

OBSERVATION:

Name of Clipper	Negative Clipper		Positive Clipper	
Wave form	Input	output	Input	output
Amplitude				
Time period				

RESULT

The output wave forms of clippers are studied.

EXPERIMENT: 04(B)

AIM OF THE EXPERIMENT

Construction of positive, negative clamper circuits and amp; study of their output waveforms by CRO.

APPARATUS REQUIRED

SL. NO.	NAME 0F APPARATUS	SPECIFICATION	QUANTITY
1	Capacitor 4.7µf		
2	IN4007 diode		
3	Resistor 1M Ω		
4	Function Generator		
5	Bread board		
6	CRO with CRO probes.		
7	Connecting wire		

THEORY

Clamping is a function which must be frequently performed with a periodic waveform in the establishment of the recurrent positive or negative extremity at some constant reference level. Clamping circuits are also referred to as dc restorer or dc inserter.

A positive clamper adds positive dc level and a negative clamper adds a negative dc level. A positive clamper clamps a negative extremity of the input signal to the reference voltage level. A negative clamper adds to negative dc level by clamping the positive extremity of the input to the reference voltage level.

CIRCUIT DIAGRAM:

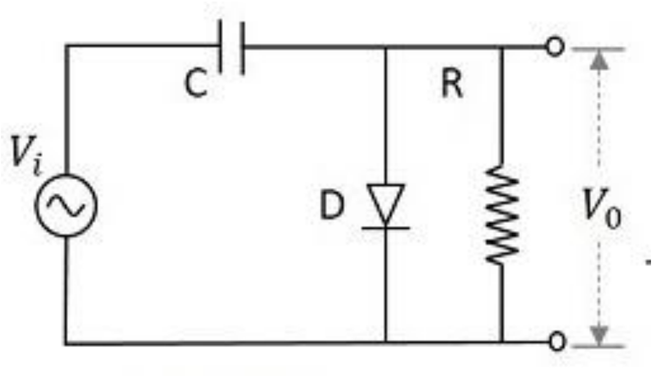


Fig. 4.3: Negative Clampper

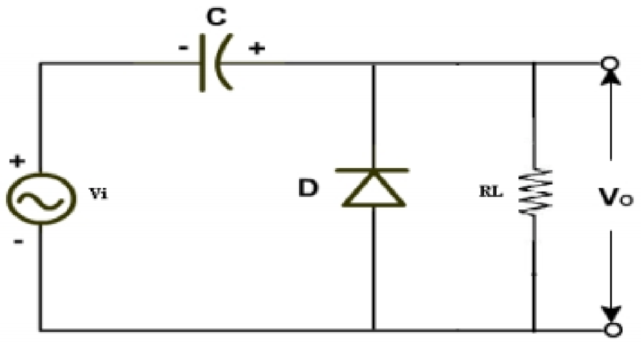


Fig. 4.4: Positive Clampper

PROCEDURE

- The circuits are connected as per the circuit diagram.
- The input signal Vi of (10V p-p) frequency (1KHz) is applied to each of the circuits.
- The corresponding output waveforms are noted from the C.R.O.

OBSERVATION:

Name of Clipper	Negative Clamper		Positive Clamper	
Wave form	Input	Output	Input	Output
Amplitude				
Time period				

RESULT

The output wave forms of clampers are studied.

EXPERIMENT: 05

AIM OF THE EXPERIMENT

Design of inverting and non-inverting amplifiers using op-amp for a given gain with the help of breadboard and distinct components.

APPARATUS REQUIRED

SL. NO.	NAME 0F APPARATUS	SPECIFICATION	QUANTITY
1	Op-amp Diode Trainer Kit		
2	Connecting Wires		

THEORY

Operational Amplifier commonly known as Op-Amp, is a linear electronic device having three terminals, two high impedance input and one output terminal. Op-Amp can perform multiple function when attached to different feedback combinations like resistive, capacitive or both. Generally it is used as voltage amplifier and the output voltage of the Op-Amp is the difference between the voltages at its two input terminals.

Op-Amp shows some properties that make it an ideal amplifier, its open loop gain and input impedance is infinite (i.e., practically very high), Output impedance and offset voltage is zero(i.e., practically very low) and bandwidth is infinite(i.e., practically limited to frequency where its gain become unity).

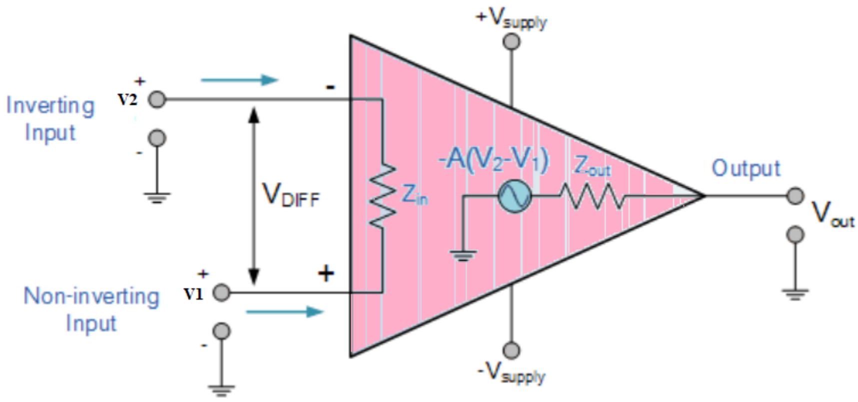


Fig 5.1: Operational Amplifier

Inverting Op-Amp

The open loop gain (Ao) of the Op-Amp is very high which makes it very unstable, so to make it stable with a controllable gain, a feedback is applied through some external resistor(Rf) from its output to inverting input terminal(i.e., also known as negative feedback) resulting in reduced gain(closed loop gain, Av). So, the voltage at inverting terminal is now the sum of the actual input and feedback voltages, and to separate both an input resistor (Ri) is introduced in the circuit. The non-inverting terminal of the op-amp is grounded, and the inverting terminal behaves like a virtual ground as the junction of the input and feedback signal are at the same potential.

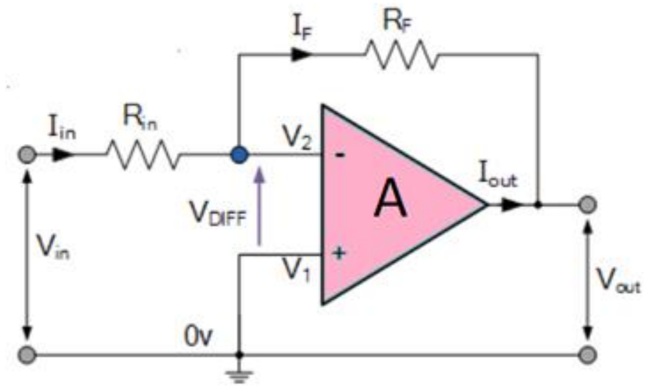


Fig 5.2: Inverting Op-amp

Current can be given

$$I = \frac{(V_{in} - V_{out})}{(R_{in} + R_F)}$$

or

$$I = \frac{(V_{in} - V_2)}{R_{in}}$$

or

$$I = \frac{(V_2 - V_{out})}{R_F}$$

$$I = \frac{V_{in}}{R_{in}} - \frac{V_2}{R_{in}} = \frac{V_2}{R_F} - \frac{V_{out}}{R_F}$$

So,

$$\frac{V_{in}}{R_{in}} = V_2 \times \left(\frac{1}{R_{in}} + \frac{1}{R}\right) - \frac{V_{out}}{R_F}$$

And as, $V_2 = 0$

$$I = \frac{(V_{in} - 0)}{R_{in}} = I = \frac{(0 - V_{out})}{R_F}$$

or $\frac{R_F}{R_{in}} = -\frac{V_{out}}{V_{in}}$

The close loop gain (A_{cl}) is given by: -

$$A_{cl} = \frac{V_{out}}{V_{in}} = -\frac{R_F}{R_{in}}$$

Output voltage (V_{out}) is given by: -

$$V_{out} = -\frac{R_F}{R_{in}} \times V_{in}$$

Non Inverting Op-Amp

In this configuration of Op-amp the input signal is directly fed to the non-inverting terminal resulting in a positive gain and output voltage in phase with input as compared to inverting Op-amp where the gain is negative and output voltage is out of phase with input , and to stabilize the circuit a negative feedback is applied through a resistor(Rf) and the inverting terminal is grounded with a input resistor(R2).This inverting Op-Amp like layout the at inverting terminal creates a virtual ground at the summing point make the Rf and R2 a potential divider across inverting terminal, Hence determines the gain of the circuit.

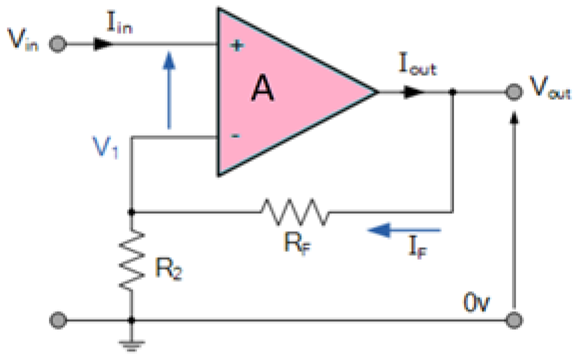


Fig 5.3: Non-Inverting Op-amp

Potential difference V_1can be written as

$$V_1 = \frac{R_2}{(R_2 + R_F)} \times V_{out}$$

in ideal condition: $V_1 = V_{in}$

So,

$$V_{in} = \frac{R_2}{(R_2 + R_F)} \times V_{out}$$

and as we know gain $A_{cl} = \frac{V_{out}}{V_{in}}$

$$A_{cl} = \frac{V_{out}}{V_{in}} = \frac{(R_2 + R_F)}{R_2} = 1 + \frac{R_F}{R_2}$$

and output voltage (V_{out}) is given by:

$$V_{out} = 1 + \frac{R_F}{R_2} \times V_{in}$$

PROCEDURE

Operational Amplifier as Inverting Amplifier:

- Set up the circuit as shown in fig.
- Test the circuit by applying the input signal of suitable amplitude (say 1V). Observe the output voltage.

- Step (3) is repeated for different input voltages.
- Determine the gain with the formula, $A_{cl} = -\frac{R_F}{R_{in}}$

Operational Amplifier as Non-Inverting Amplifier:

- Set up the circuit as shown in fig.
- Test the circuit by applying the input signal of suitable amplitude (say 1V). Observe the output voltage.
- Step (3) is repeated for different input voltages.
- Determine the gain with the formula, $A_{cl} = 1 + \frac{R_F}{R_2}$.

OBSERVATION

Table 5.1: Inverting Op-Amp

SL. NO.	Input Voltage	Output Voltage	Gain

Table 5.2: Non-Inverting Op-Amp

SL. NO.	Input Voltage	Output Voltage	Gain

RESULT

The basic op-amp circuits of inverting and non-inverting amplifiers were designed. The gain obtained are;

Inverting Amplifier:

Gain = ___________

Non-inverting Amplifier:

Gain = ___________

<u>EXPERIMENT</u>: 06

AIM OF THE EXPERIMENT

Study and realization of logic gates. (Truth table verification)

APPARATUS REQUIRED

SL. NO.	NAME 0F APPARATUS	SPECIFICATION	QUANTITY
1	Logic Gate Trainer Kit		
2	IC Chips		
3	Connecting Wires		

THEORY

AND GATE:

The AND Gate has N(N>=2) inputs and 1 output. Digital Signals are applied at the input terminals marked as A, B, N and the output is obtained at the output terminal marked as Y. Mathematically it is represented as Y= A AND B=A.B. This operation is also called as Logic Product. In AND operation the output is always 1 when all the inputs are at Logic1.It can be defined in the form of truth table which is given below.

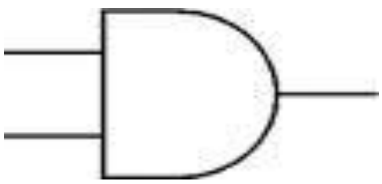


Fig. 6.1: Symbolic Representation:

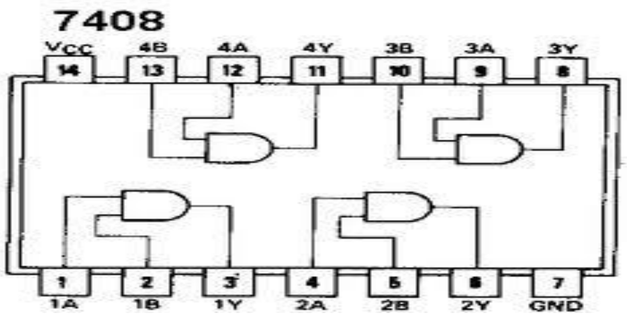


Fig. 6.2: Chip Configuration

TRUTH TABLE:

Input		**Output**
A	**B**	**Y**
0	0	0
0	1	0
1	0	0
1	1	1

OR GATE:

This operation is also called as Logical Sum operation. This has N(N>=) inputs and 1 output as their respective terminals. The OR operation always 1 if any one of the inputs is 1 else 0.The OR operator is denoted by + sign. If A & B are the inputs and Y be the output, then this can be represented as: Y= A OR B=A+B. The standard symbol and logical truth table is given below.

Fig. 6.3: Symbolic Representation:

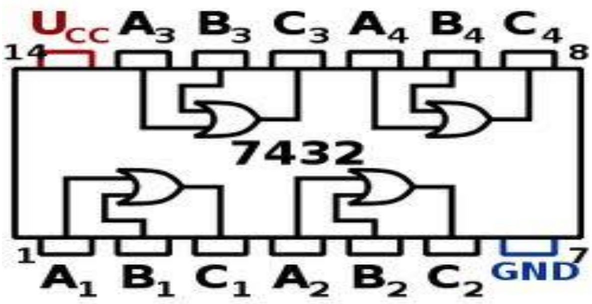


Fig. 6.4: Chip Configuration (7432)

TRUTH TABLE:

Input		output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

NOT GATE:

This operation is also called as Inverter. In this operation the output is just opposite input. If the input is 0 then the output is 1 and vice versa.The NOT Gate is Denoted by dash (’) sign which is called as the complement such as Y=NOT A=A’.

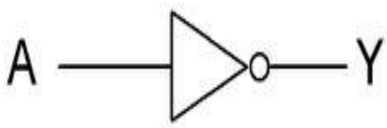


Fig. 6.5: Symbolic Representation:

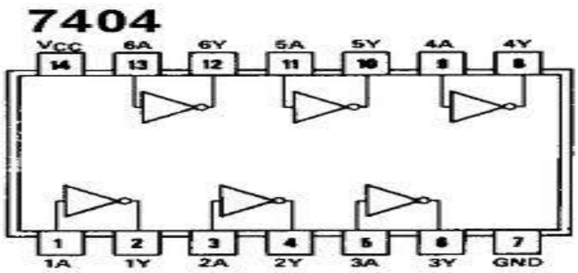


Fig. 6.6: Chip Configuration (7404)

TRUTH TABLE:

Input	output
A	y
0	1
1	0

NAND GATE:

This operation is a combination of AND Gate and NOT Gate. In other words, it is defined as an AND Operation followed by a NOT operation. In this operation the output is 0 when both the inputs are 1 else it is 1. If A and B are the two inputs then the output= (A. B)’. Using NAND Gates, we can derive all others gates and that is the reason it is called as an universal Gate. The IC No. is 7400.

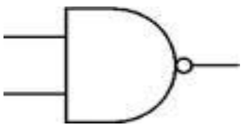


Fig. 6.7: Symbolic Representation:

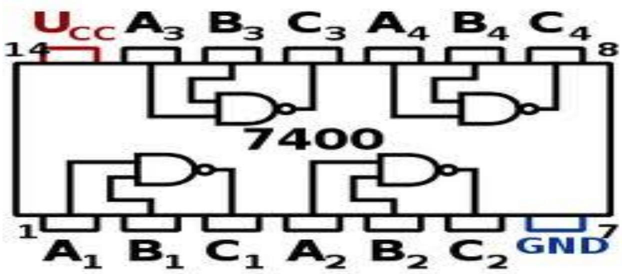


Fig. 6.8: Chip Configuration

TRUTH TABLE:

Input	Output
A B	Y
0 0	1
0 1	1
1 0	1
1 1	0

NOR GATE:

This is operation is a combination of OR Gate and NOT Gate. In other words, it is defined as an OR operation followed by a NOT operation. In this operation the output is 1 when both the inputs are 0, else it is 0. If A and B are the two inputs then the output Y= (A+B)’. The IC No. is 7402.

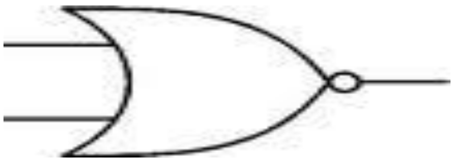


Fig. 6.9: Symbolic Representation:

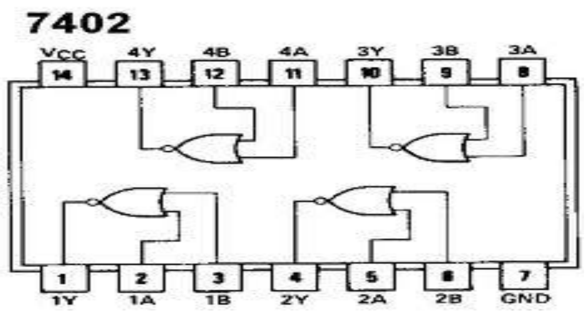


Fig. 6.10: Chip Configuration

TRUTH TABLE: (7402):

Input		output
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

EX_OR GATE:

It is also called as a Derived Gate because it can be derived from the basic Gates or even from the Universal Gates. In this operation the output is 0 when both the inputs are same and is 1 when both the inputs are different. If A and B are the inputs to the EX_OR Gate then the output is defined as Y= (A□B). The IC No. is 7486.

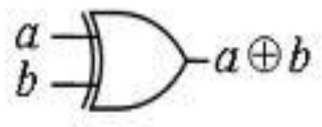


Fig. 6.11: Symbolic Representation:

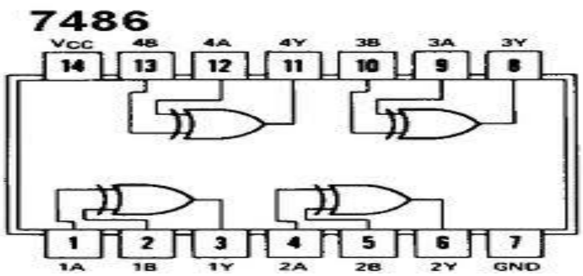


Fig. 6.12: Chip Configuration

TRUTH TABLE: (7486)

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

PROCEDURE:

- First the IC is inserted on the logic gate trainer kit.
- 7th pin is connected to Ground and 14th pin is given a supply of 5v.
- The digital signals are given to the respective pin nos. as per the block diagram of the respective ICs.
- The output is checked and verified as per the truth table of the respective gates.

OBSERVATION

AND GATE:

A	B	Y
0	0	
0	1	
1	0	
1	1	

OR GATE

A	***B***	***Y***
0	0	
0	1	
1	0	
1	1	

NOT GATE

A	**Output**
0	
1	

NAND GATE

A	**B**	**Y**
0	0	
0	1	
1	0	
1	1	

NOR GATE

A	**B**	**Y**
0	0	
0	1	
1	0	
1	1	

EX_OR GATE

A	B	Y
0	0	
0	1	
1	0	
1	1	

RESULT

The logical behaviour of the gates were studied using microprocessor integrated circuits and corresponding truth table is verified.