

UNIT-3.  
ELECTRICAL SAFETY,  
WIRING  
&  
INTRODUCTION TO POWER  
SYSTEM

# ELECTRICAL WIRING

# HOUSE WIRING

House wiring deals with the distribution system arranged within the domestic premises. Wiring requirement varies with customer to customer. House wiring generally done on either 230 V single phase or 400 V three phase supply. In the latter case, total load is divided among the three phases. An earth wire is also run connecting all the power plugs from where large quantity of electrical energy is tapped by using electrical appliances like heater, electric iron, hot plate, air conditioner etc.

## Wiring materials and accessories

The following are the wiring material used for house wiring:

Switches      Lamp holders      Ceiling roses

Socket out-lets      Switch boards      Wires

Miniature circuit breaker      Fuse unit

The accessories used for house wiring are:

Screw driver      Cutting pliers      Nose pliers      Wire stripper      Knife

Hammer      Drilling machine      Test lamp      Wood saw      Hack saw

# TYPES OF WIRING

The type of wiring depends on environment, durability, safety, appearance and cost.

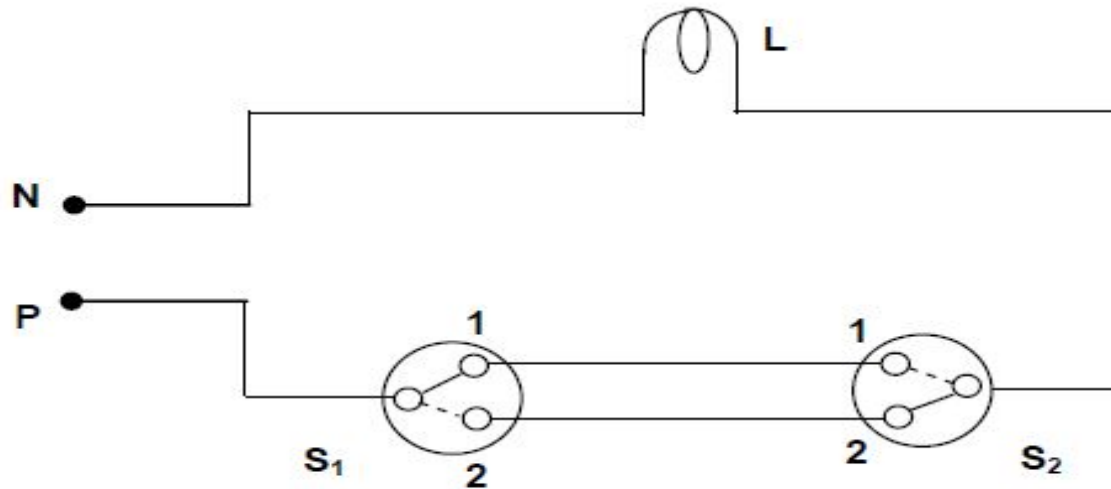
**Cleat Wiring:** In this system, V I R (Vulcanised India Rubber) conductor are supported in porcelain cleats. It is much cheaper; but will not provide good appearance.

**Wooden Casing Capping:** This system is more commonly used. It consists of rectangular wooden blocks, called casing. It has two grooves into which the wires are laid. Two or three wires of same polarity may be run in one groove. Wires of opposite polarity are not run in the same groove. The wooden casing at the top is covered by means of capping and is screwed on it. Nowadays the wooden casing and cappings are replaced by plastic to give good appearance and long life.

**Conduit Wiring:** In this system of wiring, V I R conductors are run inside metallic pipes called conduit. The conduits are buried into the walls. This system of wiring provides mechanical protection and good appearance. Nowadays instead of metal, PVC pipes are used.

# STAIRCASE WIRING

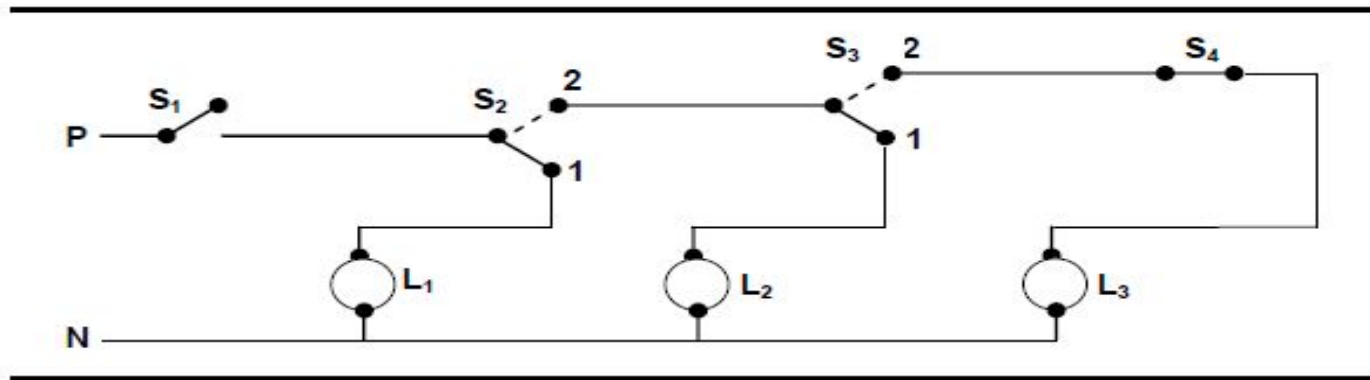
In staircase wiring a single lamp, placed at the middle of the staircase, is controlled by switches at two places, one at the beginning of the staircase and the other at the end of the staircase. For this purpose two-way switches are required. The wiring circuit is shown below.



Position of switch $S_1$	Position of switch $S_2$	Condition of lamp
1	1	ON
1	2	OFF
2	1	OFF
2	2	ON



# CORRIDOR WIRING



## Moving from left to right:

Enters	Closes $S_1$	$L_1$ ON
Reaches $S_2$	Put $S_2$ to 2	$L_1$ OFF and $L_2$ ON
Reaches $S_3$	Put $S_3$ to 2	$L_2$ OFF and $L_3$ ON
Reaches $S_4$	Opens $S_4$	$L_3$ OFF

## Moving from right to left:

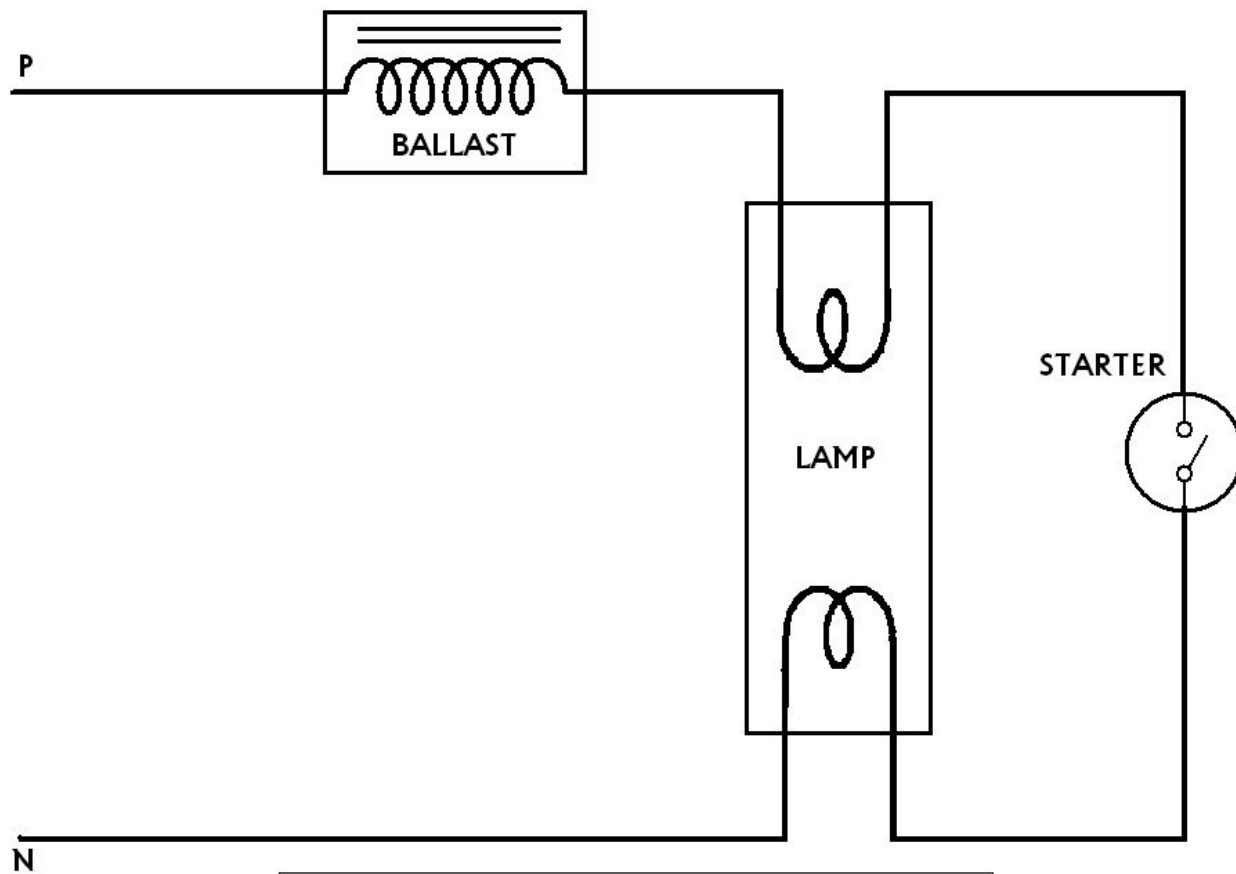
Enters	Closes $S_4$	$L_3$ ON
Reaches $S_3$	Put $S_3$ to 1	$L_2$ ON and $L_3$ OFF
Reaches $S_2$	Put $S_2$ to 1	$L_1$ ON and $L_2$ OFF
Leaves	Opens $S_1$	$L_1$ OFF

# FLUORESCENT LAMP



A fluorescent lamp or fluorescent tube is a [gas-discharge lamp](#) that uses [electricity](#) to [excite mercury vapor](#). The excited mercury atoms produce short-wave [ultraviolet](#) light that then causes a [phosphor](#) to [fluoresce](#), producing [visible light](#). A fluorescent lamp converts electrical power into useful light more efficiently than an [incandescent lamp](#). Lower energy cost typically offsets the higher initial cost of the lamp. The lamp is more costly because it requires a [ballast](#) to regulate the flow of current through the lamp.

While larger fluorescent lamps have been mostly used in commercial or institutional buildings, the [compact fluorescent lamp](#) is now available in the same popular sizes and is used as an energy-saving alternative in homes.



CIRCUIT DIAGRAM FOR FLUORESCENT LAMP WIRING



# Safety Precautions when Working with Electricity

1. Never touch or try repairing any electrical equipment or circuits with wet hands. It increases the conductivity of electric current.
2. Never use equipment with **damaged insulation** or **broken plugs**.
3. If you are working on any electrical socket at your home then always **turn off the mains**.
4. Always **use insulated tools while working**.(never\_use aluminium or steel ladder )
5. Electrical hazards include exposed **energized parts** and unguarded electrical equipment which may become **energized unexpectedly** -carries warning signs like **“Shock Risk”**. Always be observant such electrical signs.

6. when working electrical circuit always use appropriate insulated rubber gloves and goggles.

7. Never try repairing energized equipment. Always check that it is de-energized first by using a tester. When an electric tester touches a live or hot wire, the bulb inside the tester lights up showing that an electrical current is flowing through the respective wire.

8. Know the wire code of your country.

9. Always use a circuit breaker or fuse with the appropriate current rating. Circuit breakers and fuses are protection devices that automatically disconnect the live wire when a condition of short circuit or over current occurs. The selection of the appropriate fuse or circuit breaker is essential.

EARTHING

# EARTHING

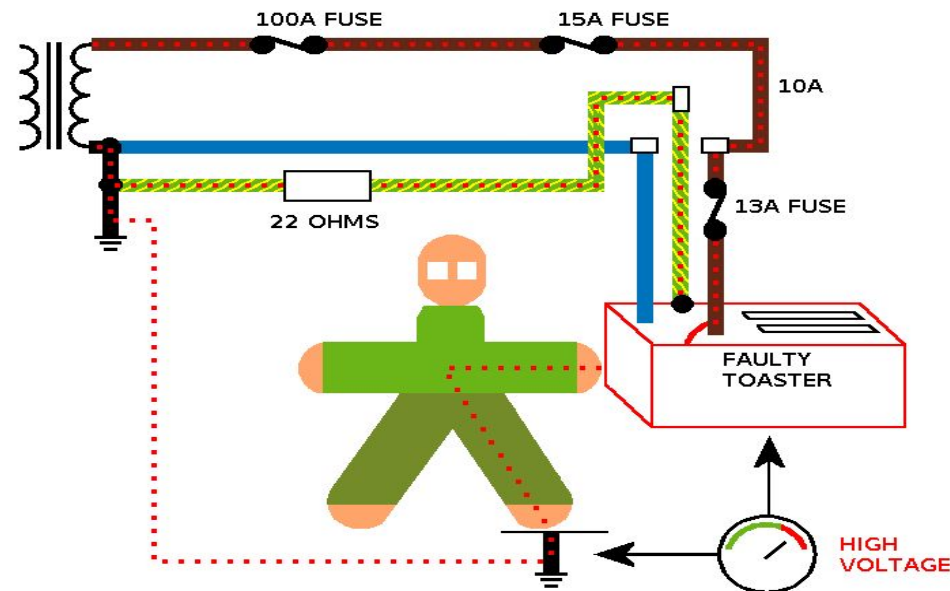
Earthing provides safe discharge of electric current due to leakages and faults to ground.

All metallic parts of electrical appliances shall be connected by earth wire made of very good conductor and finally the earth wire is connected to ground.

Earthing can be done through G.I. pipe or G.I. plate buried in the ground and surrounded by charcoal and common salt to provide good conductivity. To ensure safety earth resistance should be checked now and then and it is kept at a very low value.

# What Is Earthing

The process of connecting metallic bodies of all the electrical apparatus and equipment to huge mass of earth by a wire having negligible resistance is called Earthing.





# Objectives of the earthing

- Provide an alternative path for the fault current to flow so that it will not endanger the user
- Ensure that all exposed conductive parts do not reach a dangerous potential
- Maintain the voltage at any part of an electrical system at a known value so as to prevent over current or excessive voltage on the appliances or equipment.

# Qualities Of Good Earthing

- Must be of low electrical resistance
- Must be of good corrosion resistance
- Must be able to dissipate high fault current repeatedly

# Purpose of Earthing

- To save human life from danger of electrical shock or death by blowing a fuse i.e. To provide an alternative path for the fault current to flow so that it will not endanger the user
- To protect buildings, machinery & appliances under fault conditions ie. To ensure that all exposed conductive parts do not reach a dangerous potential.
- To provide safe path to dissipate lightning and short circuit currents.
- To provide stable platform for operation of sensitive electronic equipments i.e. To maintain the voltage at any part of an electrical system at a known value so as to prevent over current or excessive voltage on the appliances or equipment .
- To provide protection against static electricity from friction

# Electric shock

- An electric shock (electrocution) occurs when two portion of a person's body come in contact with electrical conductors of a circuit which is at different potentials, thus producing a potential difference across the body.
- The human body does have resistance and when the body is connected between two conductors at different potential a circuit is formed through the body and current will flow
- When the human body comes in contact with only one conductor, a circuit is not formed and nothing happens. When the human body comes in contact with circuit conductors, no matter what the voltage is there is potential for harm.

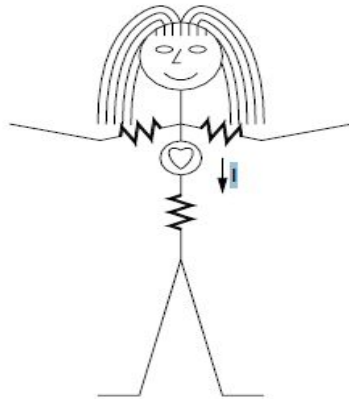
# Electric shock

- The higher the potential difference the more the damage. The effect of an electric shock is a function of what parts of body come in contact with each conductor, the resistance of each contact point the surface resistance of the body at the contact as well as other factor.
- When the electrical contact is such that the circuit path through the body is across the heart, you have the greatest potential for death.



# Electric shock

- When a high voltage such as 13,800V is involved the body is literally cooked and at times explodes



**HUMAN BODY**  
Z = 500 to 600,000 OHMS  
(DEPENDS ON SKIN MOISTURE  
AND OTHER FACTORS)

I = 250mA to 0.2mA

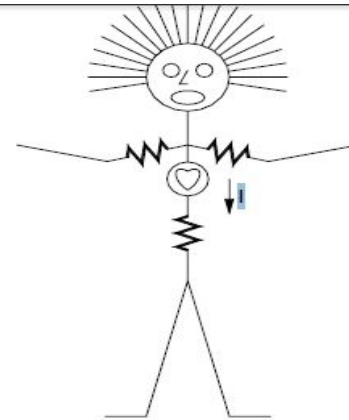
@ 120VAC

I = 550mA to 0.5mA

@ 277VAC

I = 960mA to 0.8mA

@ 480VAC



## ELECTRIC SHOCK

	AC @ 60Hz	DC
PERCEPTION LEVEL	1mA	2mA
NO-LET-GO LEVEL	15mA	300mA
FIBRILLATION LEVEL @ 0.2 SECONDS	500mA	500mA
FIBRILLATION LEVEL @ 0.5 SECONDS	75mA	400mA

# Types of Earthing

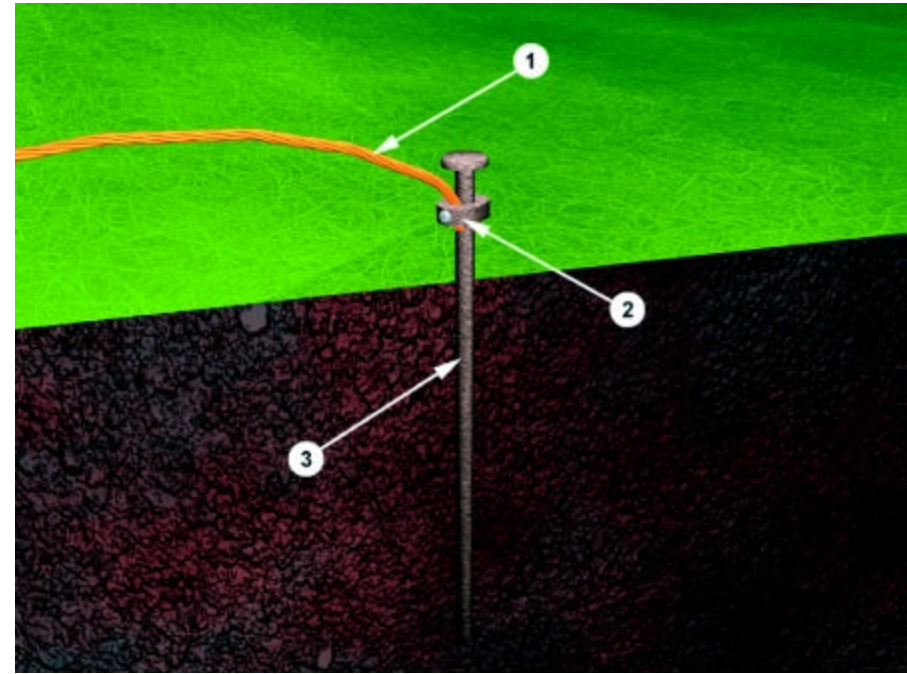
1. Plate Earthing
2. Pipe Earthing

# Earthing Electrode

**The resistance of a ground electrode has 3 basic components:**

- A) The resistance of the ground electrode itself and the connections to the electrode.
- B) The contact resistance of the surrounding earth to the electrode.
- C) The resistance of the surrounding body of earth around the ground Electrode. It consist of three basic components:

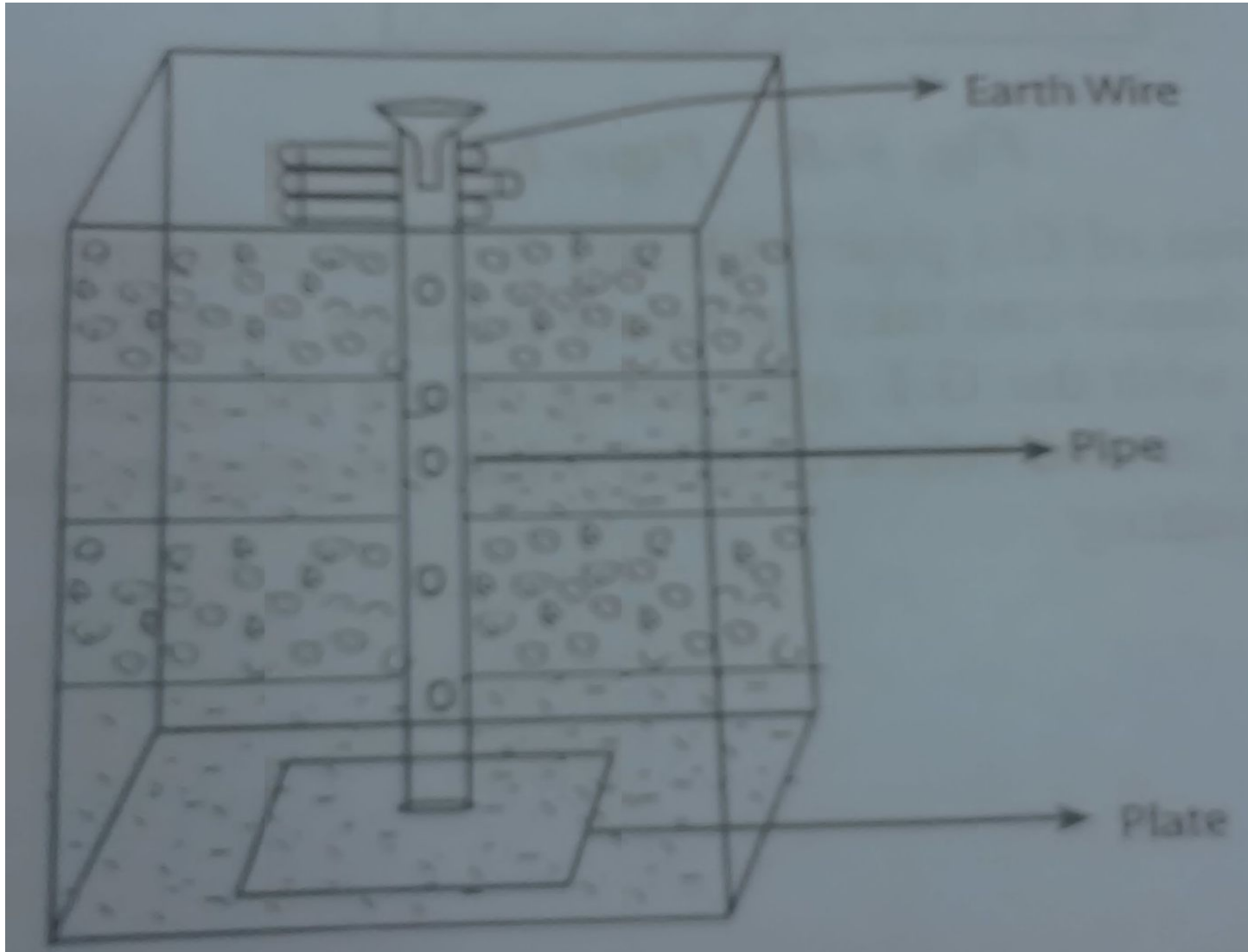
- 1. Earth Wire
- 2. Connector
- 3. Electrode



# Plate Earthing

- In this type of earthing plate either of copper or of G.I. is buried into the ground at a depth of not less than 3 meter from the ground level.
- The earth plate is embedded in alternative layer of coke and salts for a minimum thickness of about 15cm.
- The earth wire(copper wire for copper plate earthing and G.I. wire for G.I. plate earthing) is securely bolted to an earth plate with the help of bolt nut and washer made of copper, in case of copper plate earthing and of G.I. in case of G.I. plate earthing.

# PLATE EARTHING

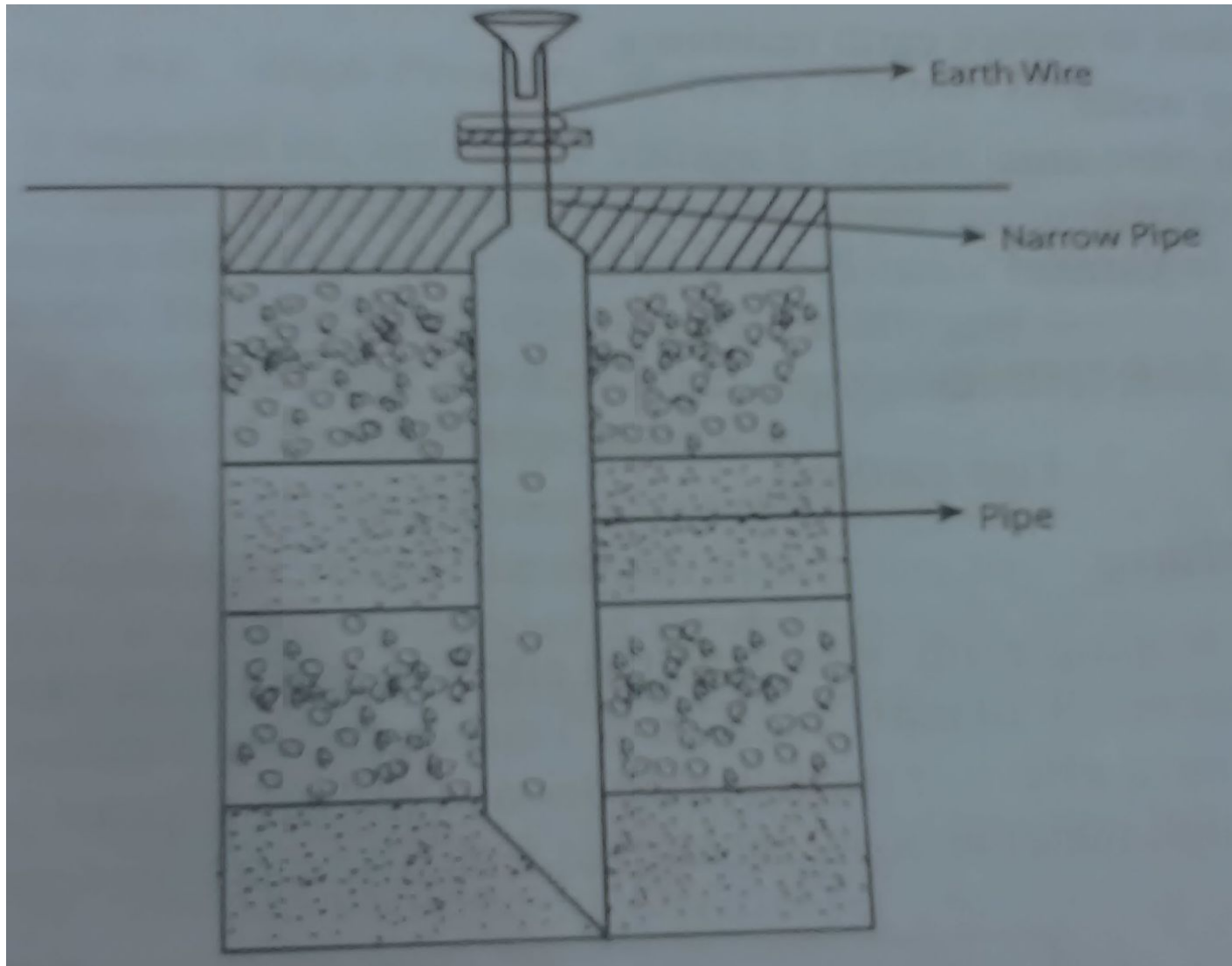




# Pipe earthing

- Pipe earthing is best form of earthing and it is cheap also in this system of earthing a GI pipe of 38 mm dia and 2meters length is embedded vertically in ground to work as earth electrode but the depth depend upon the soil conditions, there is no hard and fast rule for this.
- But the wire is embedded up to the wet soil.
- The earth wire are fastened to the top section of the pipe with nut and bolts.
- The pit area around the GI pipe filled with salt and coal mixture for improving the soil conditions and efficiency of the earthing system.
- It can take heavy leakage current for the same electrode size in comparison to plate earthing.
- The earth wire connection with GI pipes being above the ground level can be checked for carrying out continuity test as and when desired, while in plate earthing it is difficult.
- In summer season to have an effective earthing three or four bucket of water is put through the funnel for better continuity of earthing.

# PIPE EARTHING



# Unit-3 MEASURING INSTRUMENTS

- PMMC
- PMMI
- Dynamometer
- Induction
- Thermal
- Rectifier

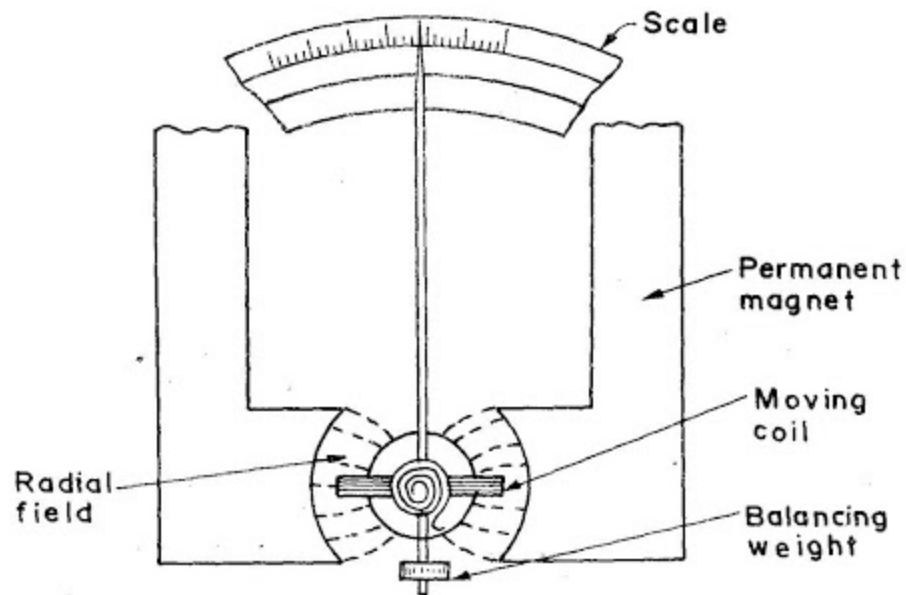
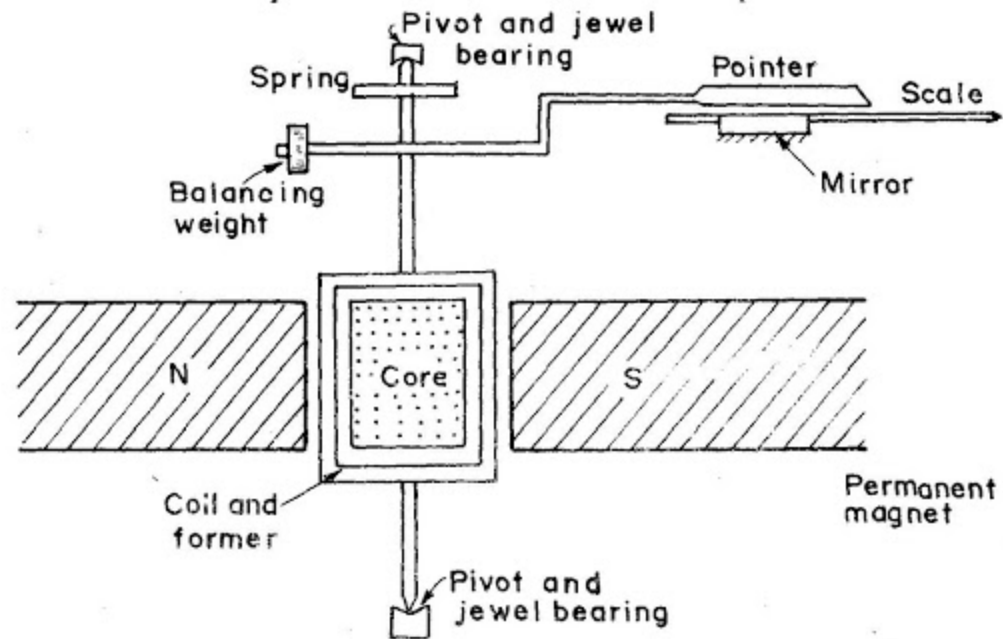
Measurement of voltage and current

# Permanent Magnet Moving Coil (PMMC) Instrument

- The **PMMC type instrument** uses two permanent magnets in order to create stationary magnetic field.
- These types of instruments are only used for measuring the dc quantities.
- If we apply ac current to these type of instruments the direction of electric current will be reversed during negative half cycle and hence the direction of torque will also be reversed which gives average value of torque zero.
- The pointer will not deflect due to high frequency from its mean position showing zero reading. However it can measure the direct current very accurately.







(a) **Stationary part or magnet system:** In the present time we use magnets of high field intensities, high coercive force instead of using U shaped permanent magnet having soft iron pole pieces. The magnets which we are using nowadays are made up of materials like alcomax and alnico which provide high field strength.

(b) **Moving coil:** The moving coil can freely moves between the two permanent magnets as shown in the figure given below. The coil is wound with many turns of copper wire and is placed on rectangular aluminium which is pivoted on jeweled bearings.

(c) **Control system:** The spring generally acts as control system for PMMC instruments. The spring also serves another important function by providing the path to lead current in and out of the coil.

(d) **Damping system:** The damping force hence torque is provided by movement of aluminium former in the magnetic field created by the permanent magnets.

(e) **Meter:** Meter of these instruments consists of light weight pointer to have free movement and scale which is linear or uniform and varies with angle.

- In PMMC meter or (D'Arsonval) meter or galvanometer all are the same instrument, a coil of fine wire is suspended in a magnetic field produced by permanent magnet.
- According to the fundamental law of electromagnetic force, the coil will rotate in the magnetic field when it carries an electric current by electromagnetic (EM) torque effect.
- A pointer which attached the movable coil will deflect according to the amount of current to be measured which applied to the coil.
- The (EM) torque is counterbalance by the mechanical torque of control springs attached to the movable coil also.
- When the torques are balanced the moving coil will stopped and its angular deflection represent the amount of electrical current to be measured against a fixed reference, called a scale.
- If the permanent magnet field is uniform and the spring linear, then the pointer deflection is also linear.

## Advantages

The various advantages of **PMMC** instruments are,

- 1) It has uniform scale.
- 2) With a powerful magnet, its torque to weight ratio is very high. So operating current is small.
- 3) The sensitivity is high.
- 4) The eddy currents induced in the metallic former over which coil is wound, provide effective damping.
- 5) It consumes low power, of the order of 25 W to 200  $\mu$ W.
- 6) It has high accuracy.
- 7) Instrument is free from hysteresis error.
- 8) Extension of instrument range is possible.
- 9) Not affected by external magnetic fields called stray magnetic fields.

## Disadvantages

The various disadvantages of **PMMC** instruments are,

- 1) Suitable for d.c. measurements only.
- 2) Ageing of permanent magnet and the control springs introduces the errors.
- 3) The cost is high due to delicate construction and accurate machining.
- 4) The friction due to jewel-pivot suspension.

# Permanent Magnet Moving Iron (PMMI) Instrument

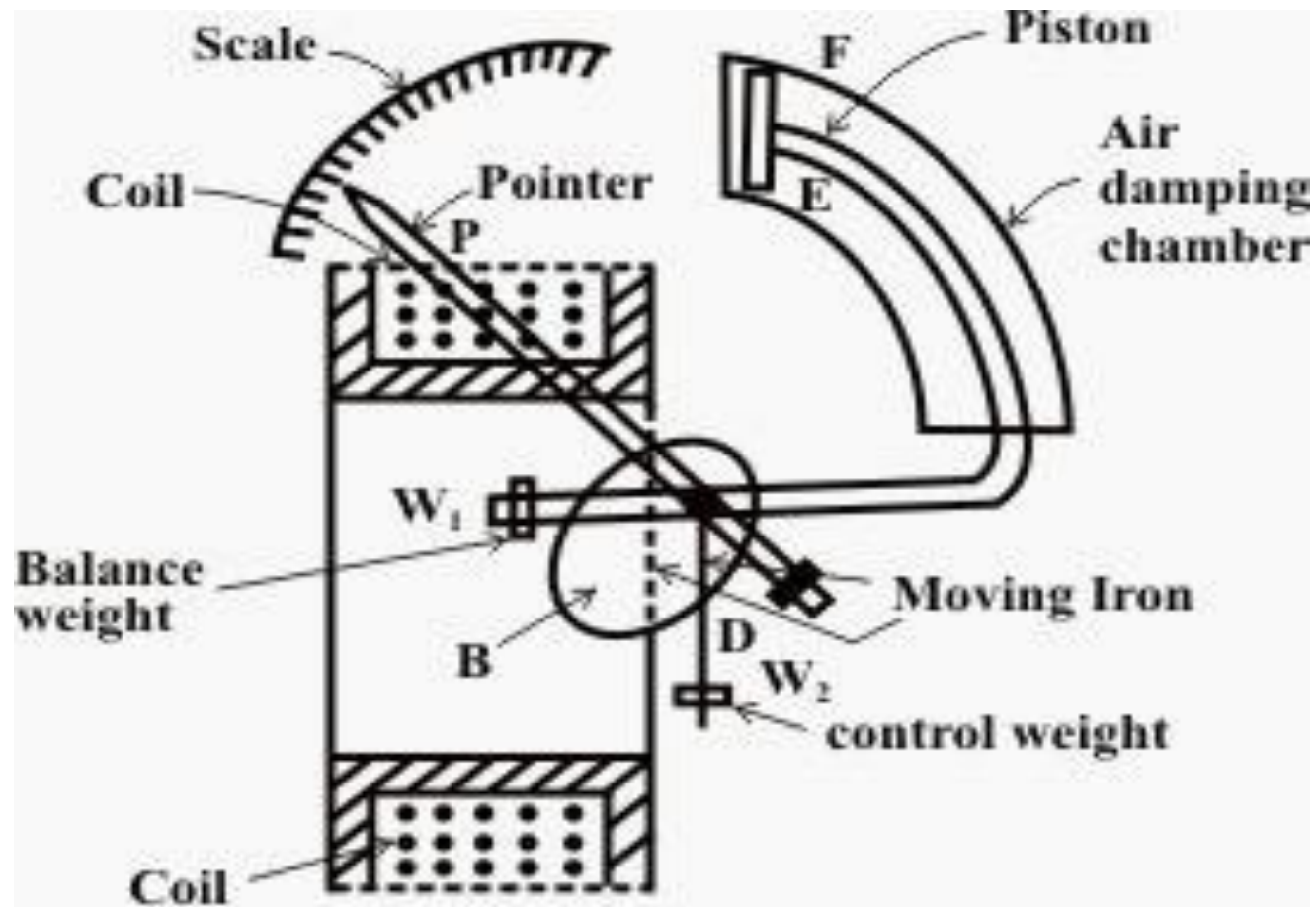
- M.I instruments are mainly used for the measurement of alternating currents and voltages, though it can also be used for D.C measurements.
- Moving iron type instruments are of mainly two types. Attraction type and repulsion type instrument.

# Attraction type Moving Iron Instrument

- Whenever a plate or vane of soft iron or of high permeability steel forms the moving element is placed nearer to a magnet it would be attracted by the magnet.
- The force of this attraction depends upon the strength said magnetic field.
- If the magnet is electromagnet then the magnetic field strength can easily be increased or decreased by increasing or decreasing electric current through its coil.
- Accordingly the attraction force acting on the piece of iron would also be increased and decreased.
- Depending upon this simple phenomenon attraction type **moving iron instrument** was developed.



In this type of instrument, a single soft iron vane (moving iron) is mounted on the spindle, and is attracted towards the coil when operating current flows through it.



- This iron tends to move inward that is from weaker magnetic field to stronger magnetic field when current flowing through the coil.
- In attraction moving instrument gravity control was used previously but now gravity control method is replaced by spring control in relatively modern instrument.
- By adjusting balance weight null deflection of the pointer is achieved.
- The required damping force is provided in this instrument by air friction.
- The figure shows a typical type of damping system provided in the instrument, where damping is achieved by a moving piston in an air syringe.

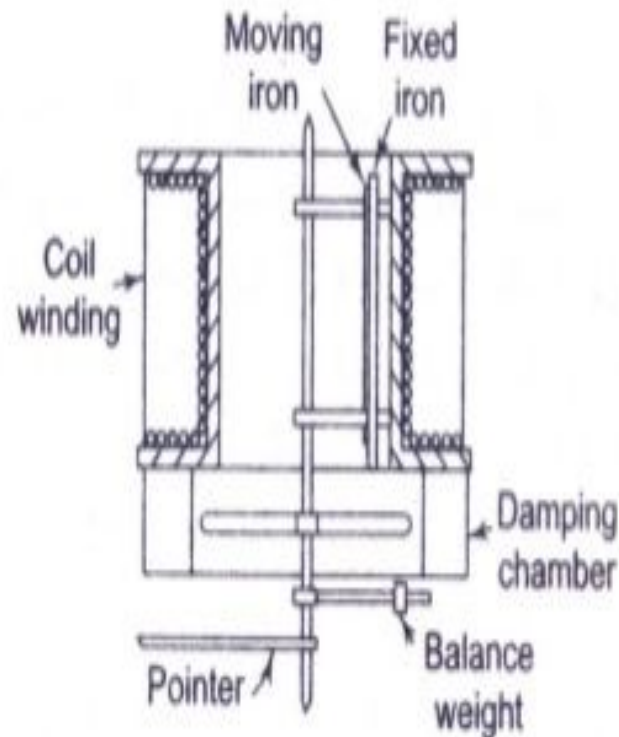
# Repulsion type Moving Iron Instrument

- In this two soft iron vanes are used
  - one fixed and attached the stationary coil,
  - other is movable (moving iron), and mounted on the spindle of the instrument.
- When operating current flows through the coil, the two vanes are magnetized, developing similar polarity at the same ends.
- Consequently, repulsion takes place between the vanes and the movable vane causes the pointer to move over the scale.

## *Moving Iron type instruments: Repulsion type*

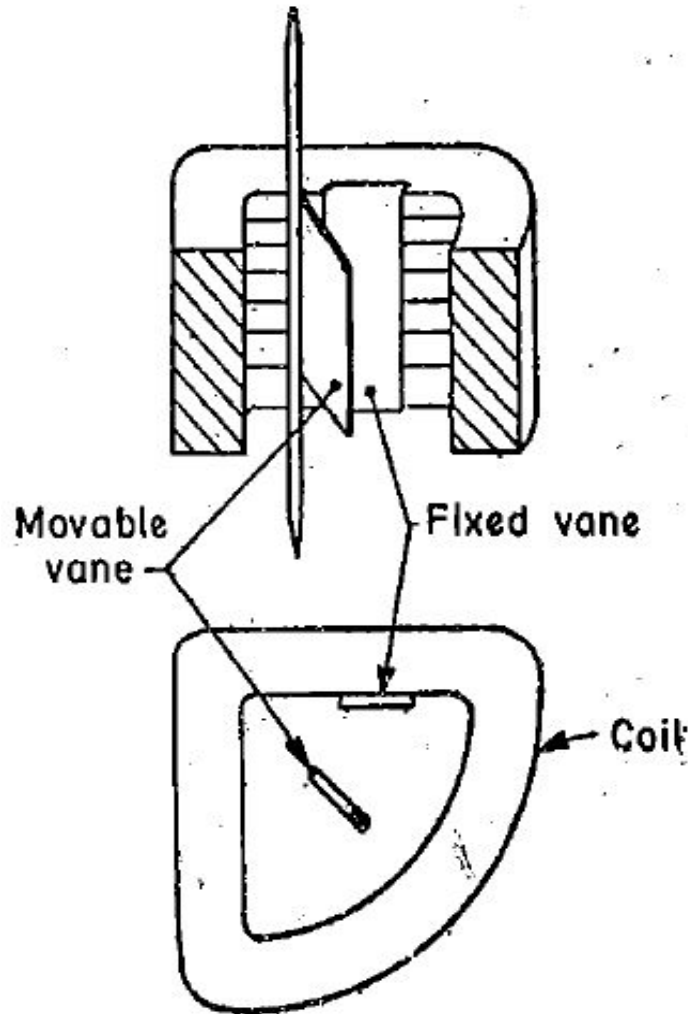
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When current flows through the coil, Two soft iron rods get magnetized similarly, causing them to repel each other.

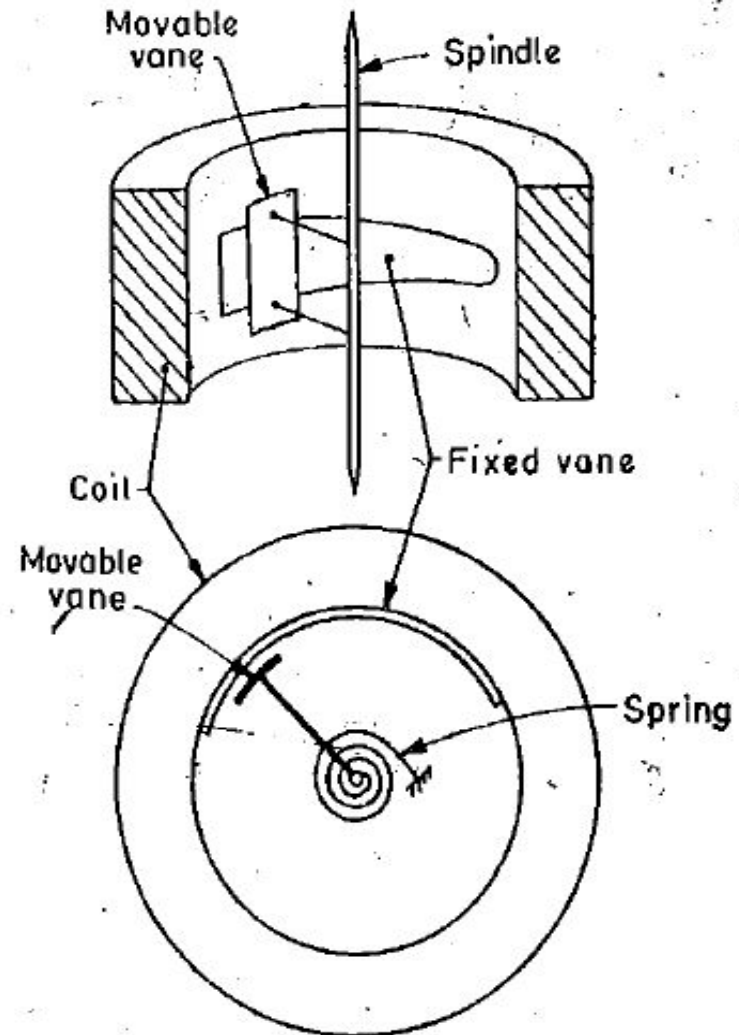


**a. Radial Vane Type:** - vanes are radial strips of iron.

**b. Co-axial Vane Type:-** vanes are sections of coaxial cylinders.



(a) Radial vane type.



(b) Co-axial vane type.

- This repulsion force is due to same magnetic poles induced in same sides the iron pieces due external magnetic field.
- This repulsion force increases if field strength of the magnet is increased. Like case if the magnet is electromagnet, then magnetic field strength can easily be controlled by controlling input current to the magnet.
- Hence if the electric current increases the repulsion force between the pieces of iron is increased and if the current decreases the repulsion force between them is decreased.
- Depending upon this phenomenon repulsion type **moving iron instrument** was constructed

## Advantages

The various advantages of **moving iron** instruments are,

- 1) The instruments can be used for both a.c. and d.c. measurements.
- 2) As the torque to weight ratio is high, errors due to the friction are very less.
- 3) A single type of **moving** element can cover the wide range hence these instruments are cheaper than other types of instruments.
- 4) There are no current carrying parts in the **moving** system hence these meters are extremely rugged and reliable.
- 5) These are capable of giving good accuracy. Modern **moving iron** instruments have a d.c. error of 2% or less.
- 6) These can withstand large loads and are not damaged even under severe overload conditions.
- 7) The range of instruments can be extended.

## Disadvantages

The various disadvantages of **moving iron** instruments are,

- 1) The scale of the **moving iron** instruments is not uniform and is cramped at the lower end. Hence accurate readings are not possible at this end.
- 2) There are serious errors due to hysteresis, frequency changes and stray magnetic fields.
- 3) The increase in temperature increases the resistance of coil, decreases stiffness of the springs, decreases the permeability and hence affect the reading severely.
- 4) Due to the non linearity of B-H curve, the deflecting torque is not exactly proportional to the square of the current.
- 5) There is a difference between a.c. and d.c. calibrations on account of the effect of inductance of the meter. Hence these meters must always be calibrated at the frequency at which they are to be used. The usual commercial **moving iron** instrument may be used within its specified accuracy from 25 to 125 Hz frequency range.
- 6) Power consumption is on higher side.



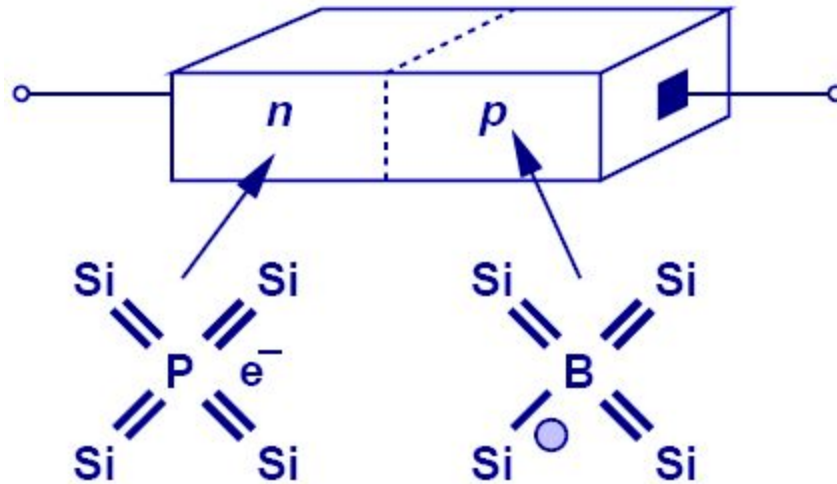
Meter Type	Control	Damping	Suitability	Application
PMMC	Spring	Eddy current	D.C.	Widely used for d.c. current and voltage measurements in low and medium impedance circuits.
Moving Iron	Spring or Gravity	Air friction	D.C. and A.C.	Used for rough indication of currents and voltages. Widely used for the indicator type instruments on panels.

# Electronic devices

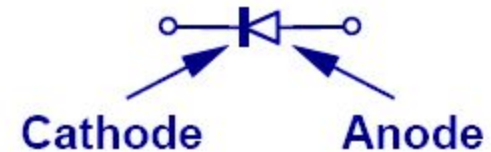
## PN- DIODE

# **SEMICONDUCTOR DIODE**

- **Theory of p-n junction**
- **p-n junction as diode**
- **p-n diode currents**
- **Volt-amp characteristics**
- **Diode resistance**
- **Temperature effect of p-n junction**
- **Transition and diffusion capacitance of p-n diode**
- **Diode switching times**



(a)

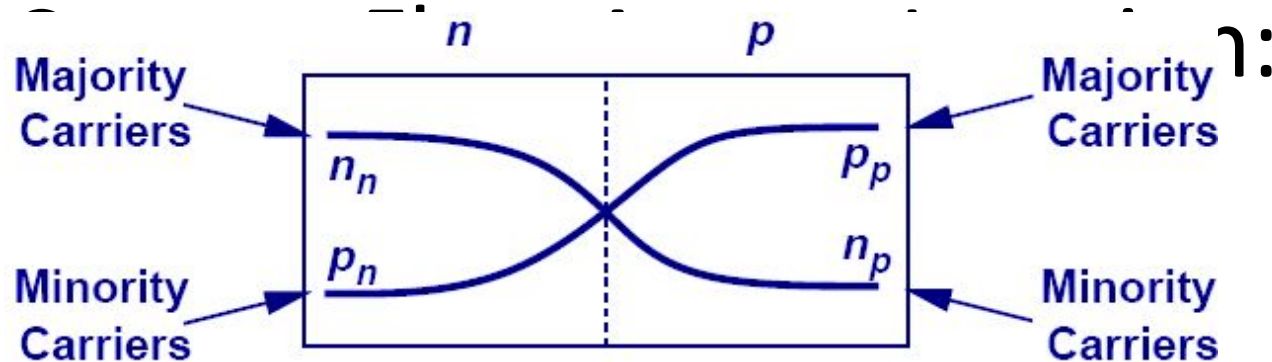


(b)

- When N-type and P-type dopants are introduced side-by-side in a semiconductor, a PN junction or a diode is formed.
- The p-n junction is also called as semiconductor diode .
- The left side material is a p-type semiconductor having –ve acceptor ions and +vely charged holes. The right side material is n-type semiconductor having +ve donor ions and free electrons

# p-n junction as diode

- Suppose the two pieces are suitably treated to form pn junction, then there is a tendency for the free electrons from n-type to diffuse over to the p-side and holes from p-type to the n-side . This process is called **diffusion**
- The left side material is a p-type semiconductor having –ve acceptor ions and +vely charged holes. The right side material is n-type semiconductor having +ve donor ions and free electrons.



$n_n$  : Concentration of electrons  
on n side

$p_n$  : Concentration of holes  
on n side

$p_p$  : Concentration of holes  
on p side

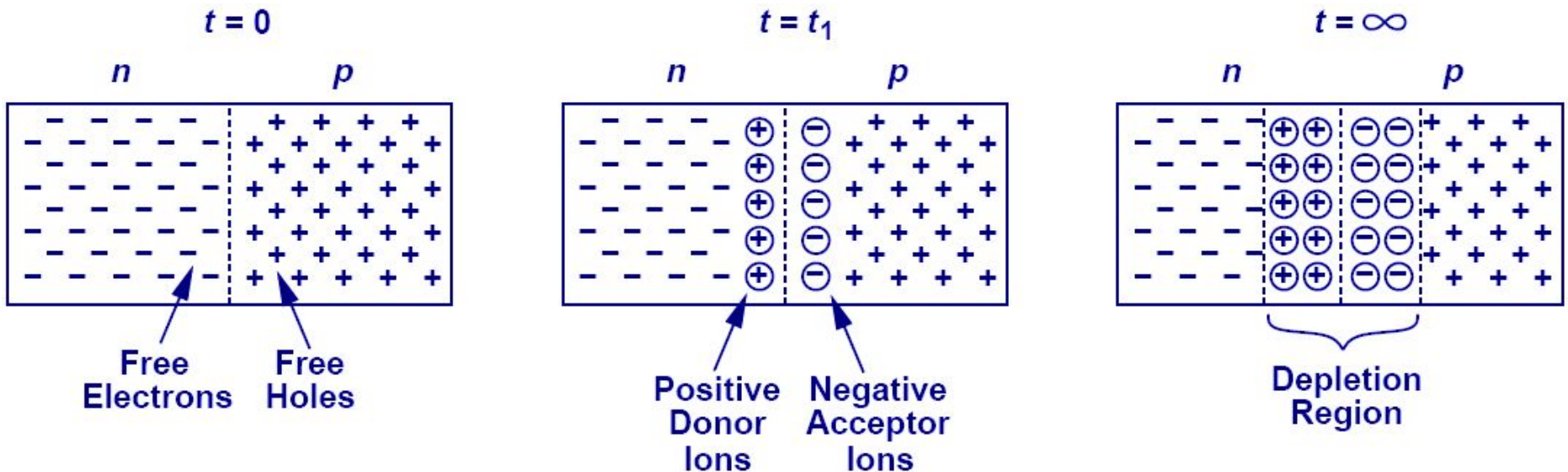
$n_p$  : Concentration of electrons  
on p side

- Because each side of the junction contains an excess of holes or electrons compared to the other side, there exists a large concentration gradient. Therefore, a diffusion current flows across the junction from each side.

# **p-n junction as diode**

- As the free electrons move across the junction from n-type to p-type, +ve donor ions are uncovered. Hence a +ve charge is built on the n-side of the junction. At the same time, the free electrons cross the junction and uncover the –ve acceptor ions by filling in the holes. Therefore a net –ve charge is established on p-side of the junction.

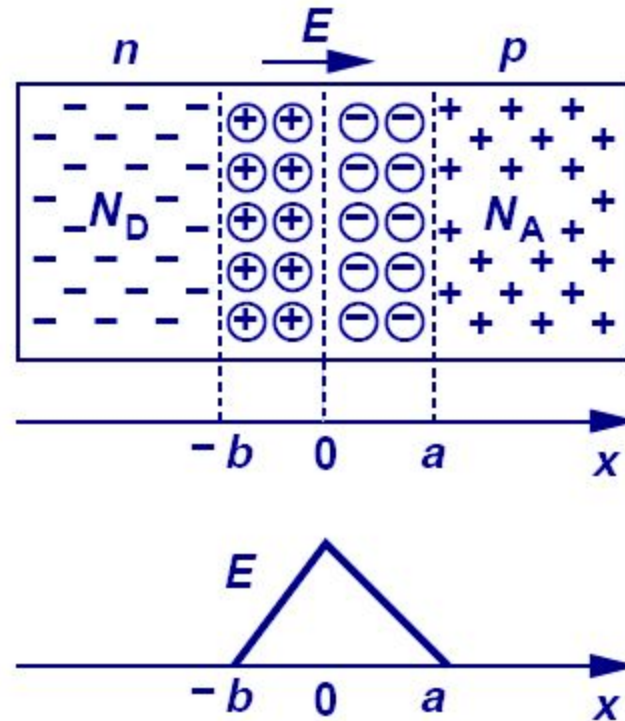
# Depletion Region



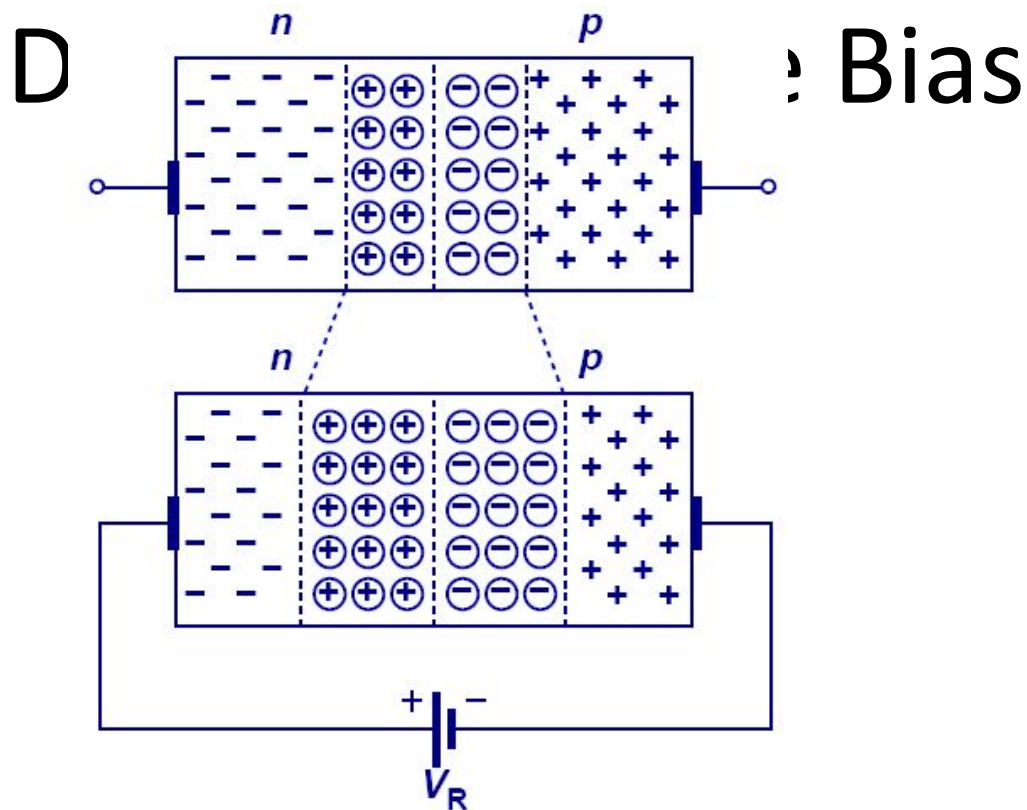
- As free electrons and holes diffuse across the junction, a region of fixed ions is left behind. This region is known as the “depletion region.”



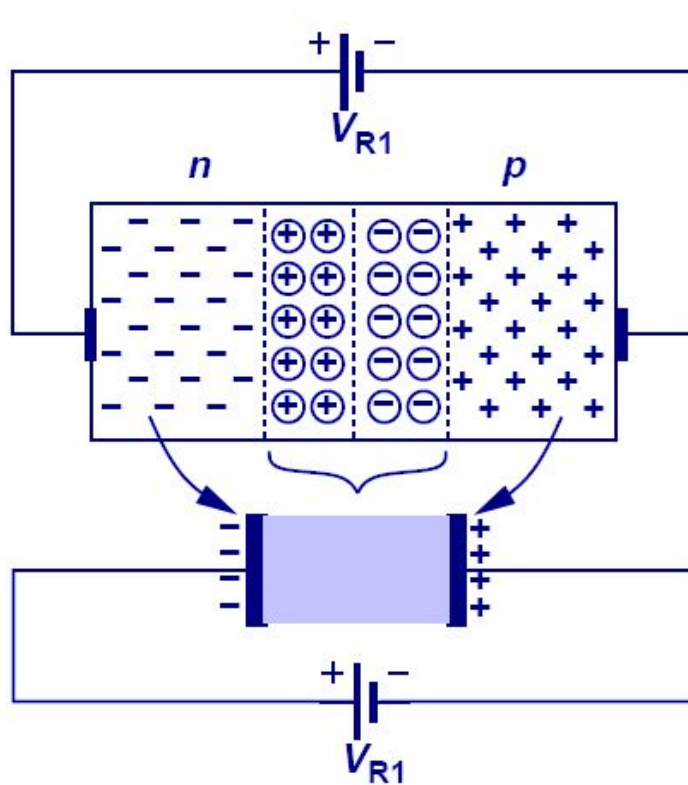
# Current Flow Across Junction: Drift



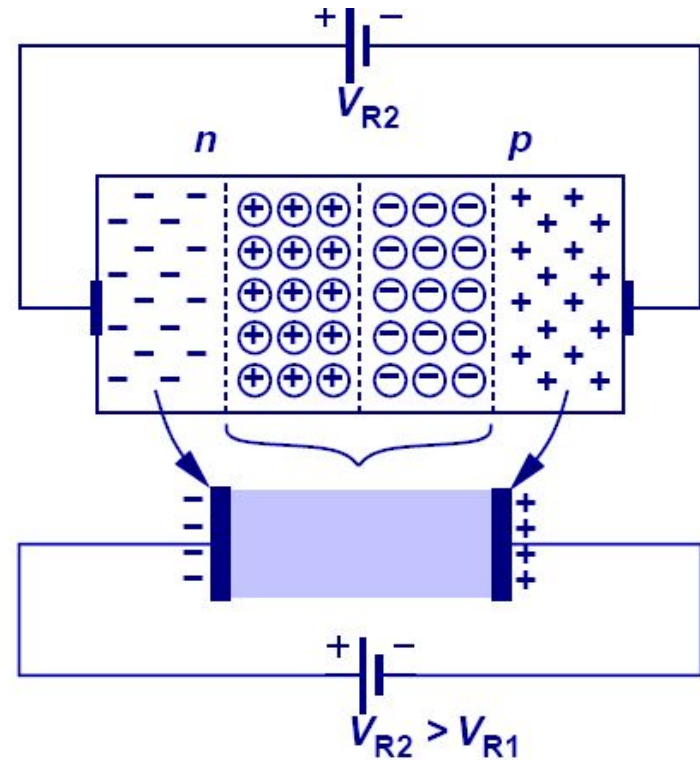
- The fixed ions in depletion region create an electric field that results in a drift current.



- When the N-type region of a diode is connected to a higher potential than the P-type region, the diode is under reverse bias, which results in wider depletion region and larger built-in electric field across the junction.



(a)



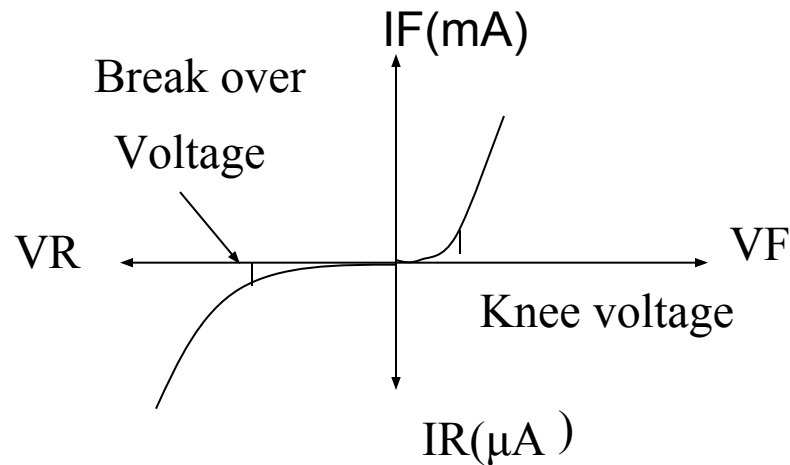
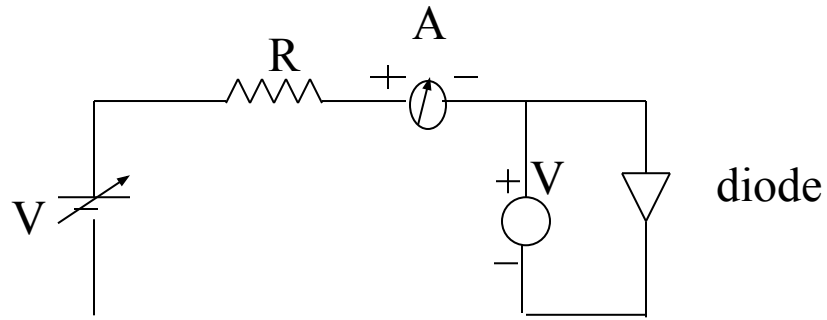
(b)

- The PN junction can be viewed as a capacitor. By varying  $V_R$ , the depletion width changes, changing its capacitance value; therefore, the PN junction is actually a voltage-dependent capacitor.

# p-n junction as diode

- When a sufficient number of donor and acceptor ions is uncovered further diffusion is prevented.
- Thus a barrier is set up against further movement of charge carriers. This is called potential barrier or junction barrier  $V_0$ . The potential barrier is of the order of 0.1 to 0.3V.
- **Note:** outside this barrier on each side of the junction, the material is still neutral. Only inside the barrier, there is a +ve charge on n-side and -ve charge on p-side. This region is called depletion layer.

# Volt-amp characteristics

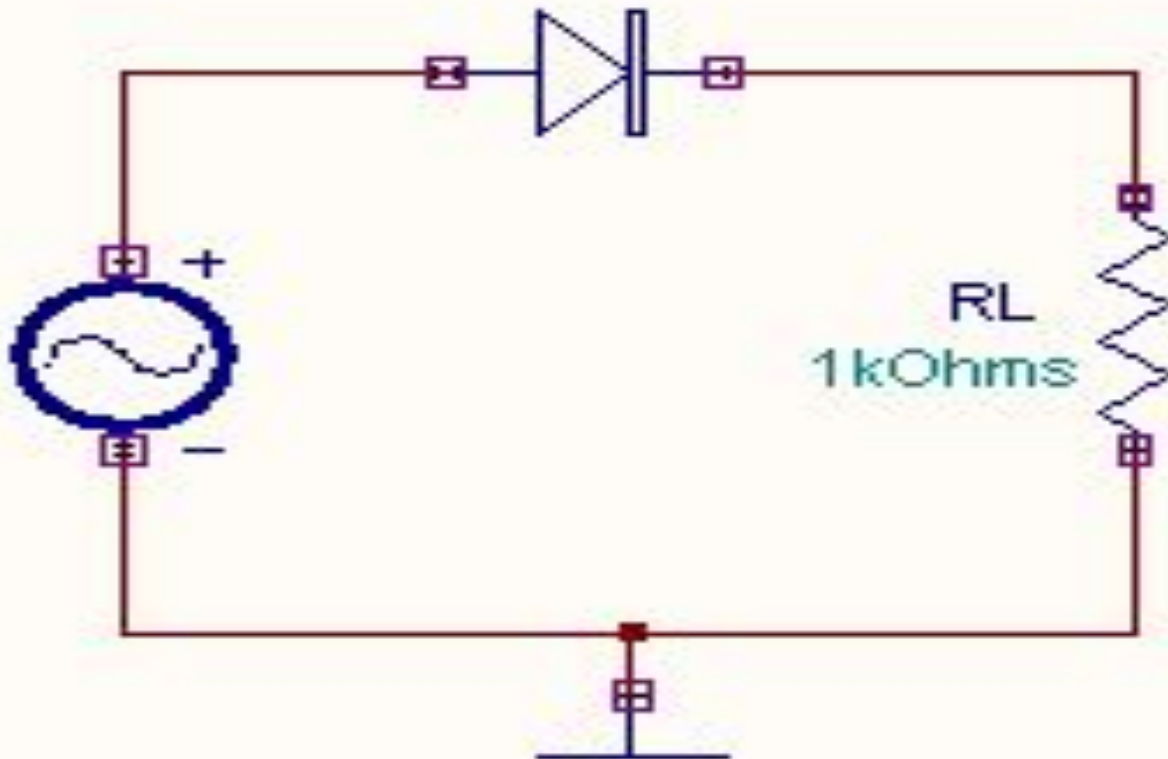


# Volt-amp characteristics

- The supply voltage  $V$  is a regulated power supply, the diode is forward biased in the circuit shown. The resistor  $R$  is a current limiting resistor. The voltage across the diode is measured with the help of voltmeter and the current is recorded using an ammeter.
- By varying the supply voltage different sets of voltage and currents are obtained. By plotting these values on a graph, the forward characteristics can be obtained. It can be noted from the graph the current remains zero till the diode voltage attains the barrier potential.
- For silicon diode, the barrier potential is 0.7 V and for Germanium diode, it is 0.3 V. The barrier potential is also called as knee voltage or cut-in voltage.

# HALFWAVE RECTIFIER

## Half Wave Rectifier



# HALFWAVE RECTIFIER

- The primary of the transformer is connected to ac supply. This induces an ac voltage across the secondary of the transformer.
- During the positive half cycle of the input voltage the polarity of the voltage across the secondary forward biases the diode. As a result a current  $I_L$  flows through the load resistor,  $R_L$ . The forward biased diode offers a very low resistance and hence the voltage



# HALFWAVE RECTIFIER

- Drop across it is very small. Thus the voltage appearing across the load is practically the same as the input voltage at every instant.
- During the negative half cycle of the input voltage the polarity of the secondary voltage gets reversed. As a result, the diode is reverse biased.
- Practically no current flows through the circuit and almost no voltage is developed across the resistor. All input voltage appears across the diode itself.

# HALFWAVE RECTIFIER

- Hence we conclude that when the input voltage is going through its positive half cycle, output voltage is almost the same as the input voltage and during the negative half cycle no voltage is available across the load.
- This explains the unidirectional pulsating dc waveform obtained as output. The process of removing one half the input signal to establish a dc level is aptly called half wave rectification.

# HALFWAVE RECTIFIER

## Peak Inverse Voltage

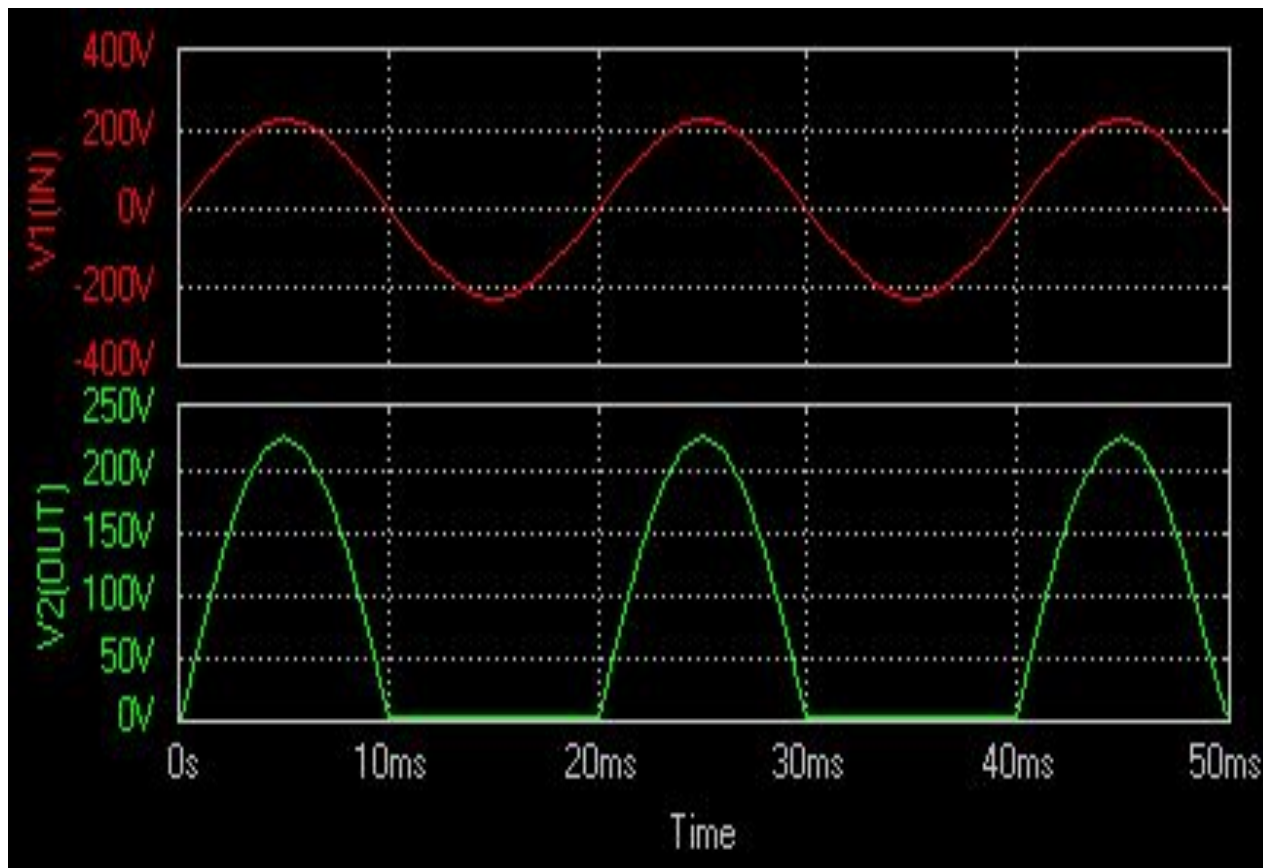
- When the input voltage reaches its maximum value  $V_m$  during the negative half cycle the voltage across the diode is also maximum. This maximum voltage is known as the peak inverse voltage.

Thus for a half wave rectifier

Let  $V_i$  be the voltage to the primary of the transformer.  $V_i$  is given by

where  $V_r$  is the cut-in voltage of the diode.

# Half wave waveform



# HALFWAVE RECTIFIER

## Ripple Factor

- Ripple factor is defined as the ratio of rms value of ac component to the dc component in the output.

Ripple factor  $r = \frac{\text{RMS value of the ac component.}}{\text{dc value of the component}}$

# HALFWAVE RECTIFIER

The ripple is

$$\gamma = \frac{V_{r_{rms}}}{V_{dc}} \rightarrow (2)$$

$$V_{r_{rms}} = \sqrt{V_{rms}^2 - V_{dc}^2} \rightarrow (3)$$

$$r = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} \rightarrow (4)$$

# HALFWAVE RECTIFIER

$V_{av}$  the average or the dc content of the voltage across the load is given by

$$V_{av} = V_{dc} = \frac{1}{2\pi} \left[ \int_0^{\pi} V_m \sin \omega t \, d(\omega t) + \int_{\pi}^{2\pi} 0 \, d(\omega t) \right] \rightarrow (5)$$

# HALFWAVE RECTIFIER

RMS voltage at the load resistance can be calculated as

$$V_{ms} = \left[ \frac{1}{2\pi} \int_0^\pi V_m^2 \sin^2 \omega t \, d(\omega t) \right]^{1/2} \rightarrow (8)$$

$$= V_m \left[ \frac{1}{4\pi} \int_0^\pi (1 - \cos 2\omega t) \, d(\omega t) \right]^{1/2} = \frac{V_m}{2} \rightarrow (9)$$



# HALFWAVE RECTIFIER

Ripple Factor

$$r = \sqrt{\left(\frac{V_m/2}{V_m/\pi}\right)^2 - 1} = \sqrt{\left(\frac{\pi}{2}\right)^2} = \underline{\underline{1.21}} \rightarrow (10)$$

# HALFWAVE RECTIFIER

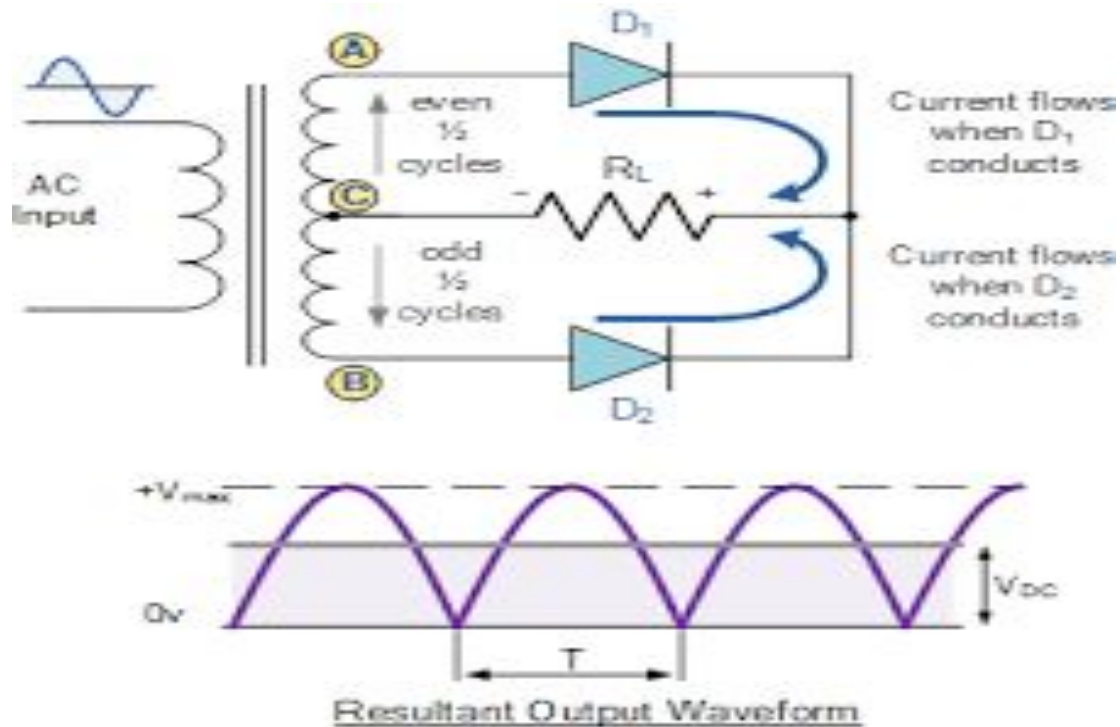
Efficiency Efficiency, is the ratio of the dc output power to ac input power

$$\eta = \frac{\text{dc output power}}{\text{ac input power}} = \frac{P_{dc}}{P_{ac}} \rightarrow (11)$$

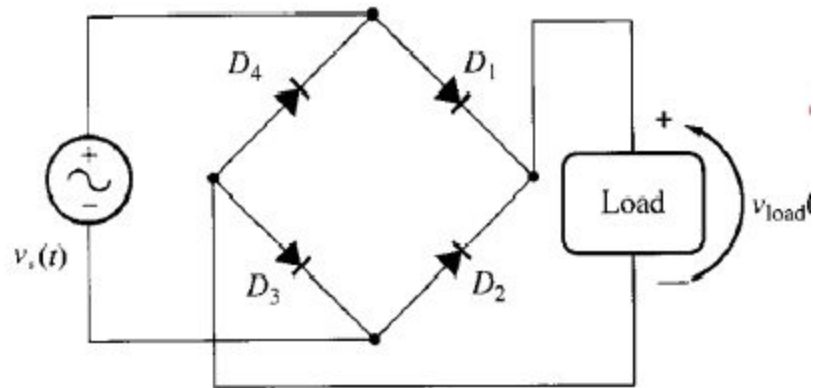
# Full Wave Rectifier

The waveform of fullwave rectifier is

Ripple factor=0.48; efficiency=81.2%; PIV=2V<sub>m</sub>

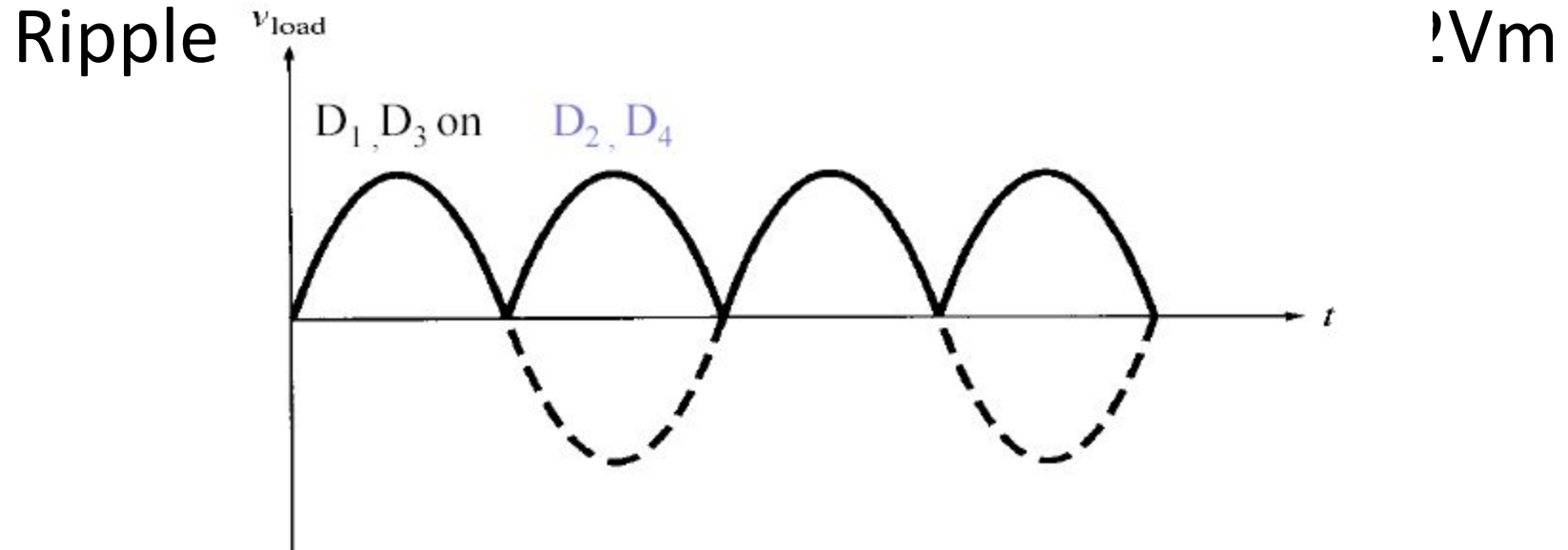


# Full Wave Bridge Rectifier



The waveform of fullwave bridge rectifier is  
Ripple factor=0.48; efficiency=81.2%; PIV= $V_m$

The waveform of fullwave rectifier is

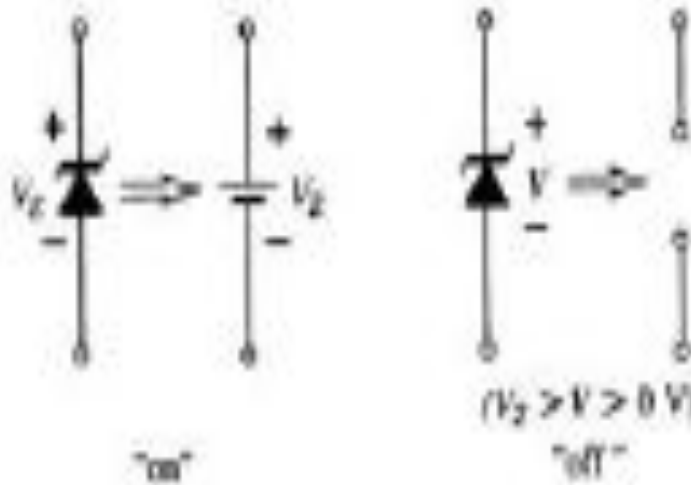


# Zener Diode

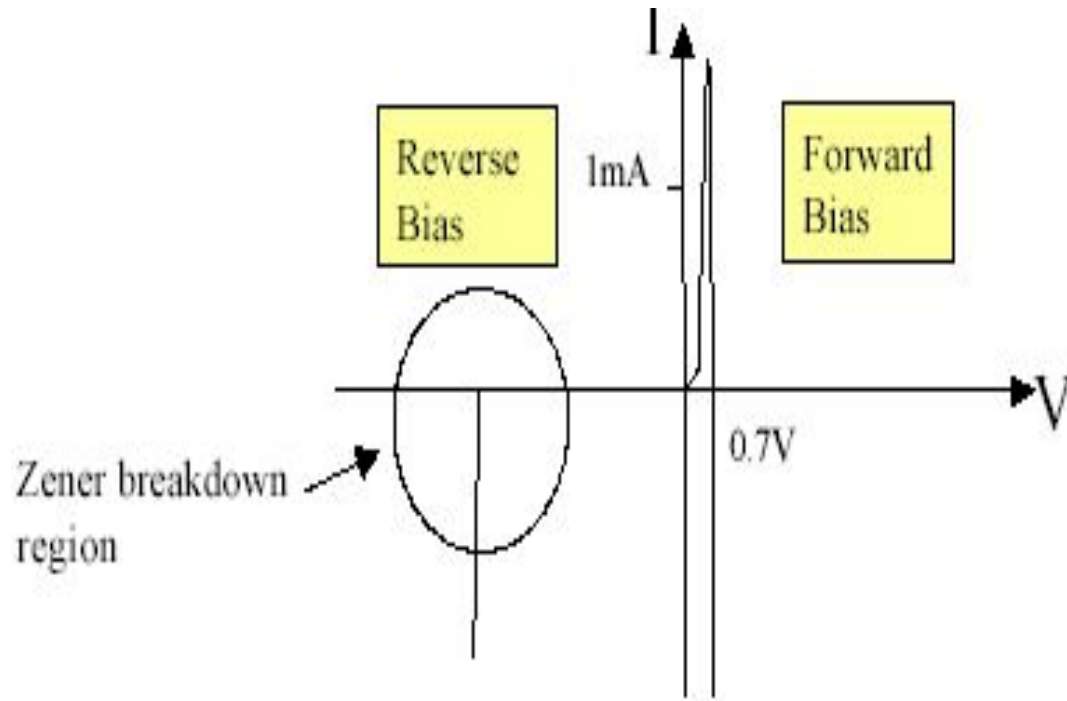
- Zener Diode : Works in the break down region when subjected to reverse bias.
- Large variation in current. Voltage almost constant.
- Used for voltage regulation. Upper limit of current depends on the power dissipation rating of the device.

# Zener Diode

Zener diode



# V-I Characteristics of Zener Diode





# V-I Characteristics of Zener Diode

- Zener diodes are manufactured to have a very low reverse bias breakdown voltage
- Since the breakdown at the zener voltage is so sharp, these devices are often used in voltage regulators to provide precise voltage references. The actual zener voltage is device dependent. For example, you can buy a 6V zener diode.

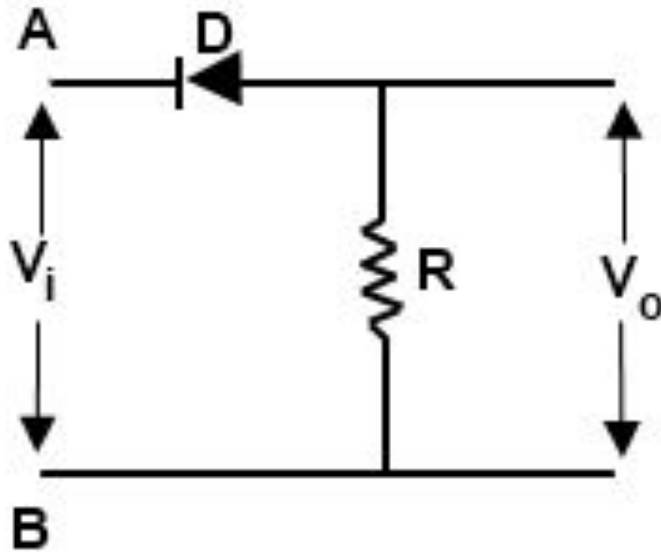
# Clipper circuits

- Clipping circuits
  - “A clipper is a device which limits, remove or prevents some portion of the wave form (input signal voltage) above or below a certain level.”
- In other words
  - “the circuit which limits positive or negative amplitude ,or both is called clipping circuit.”

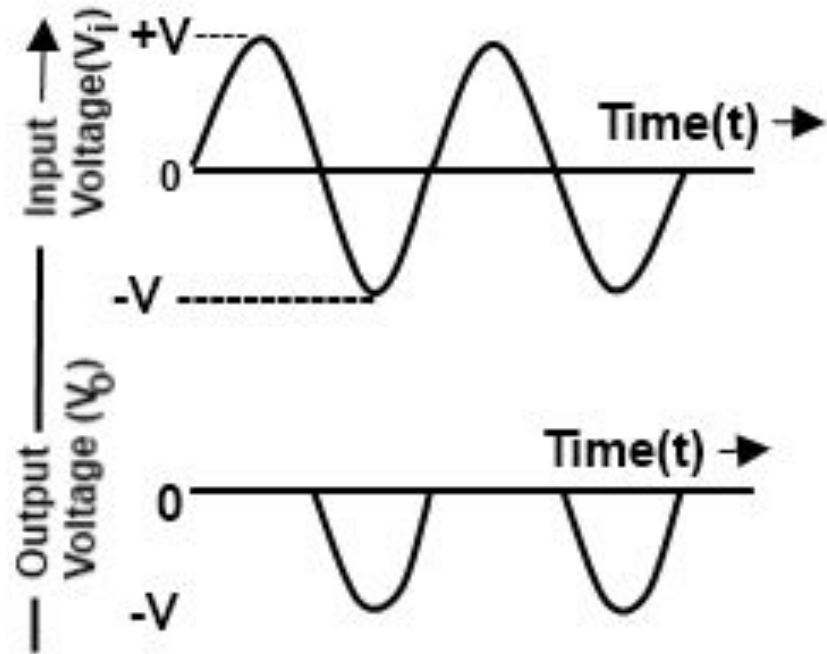
# Types of clippers

- **The clipper circuits are of the following types.**
- Series positive clipper
- Series negative clipper
- Shunt or parallel clipper
- Shunt or parallel positive negative
- Clipper Dual (combination) Diode clipper

## Series positive clipper

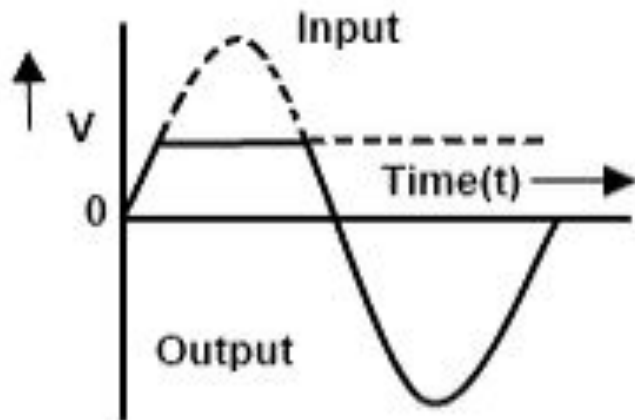
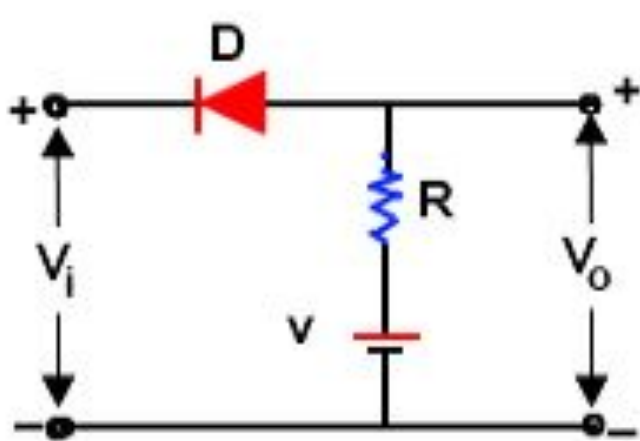


Positive clipper

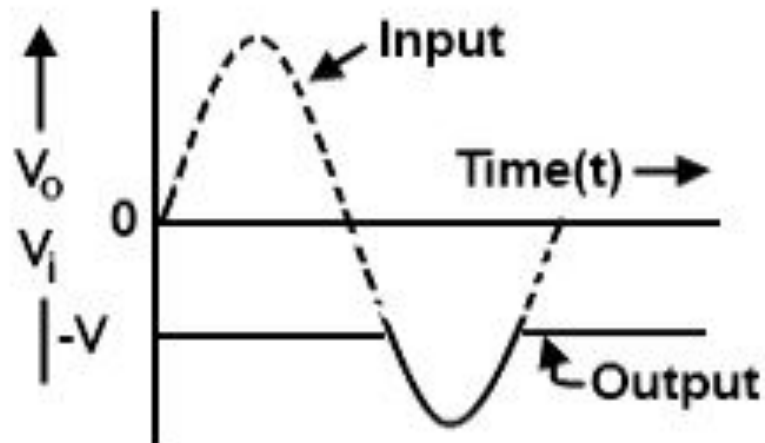
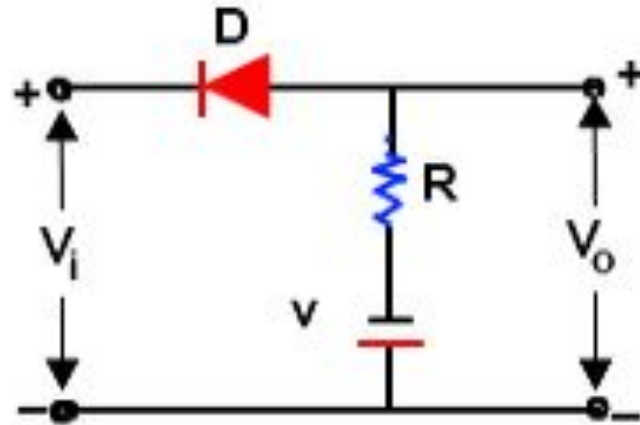


Output voltage

# SERIES-POSITIVE CLIPPER WITH BIAS

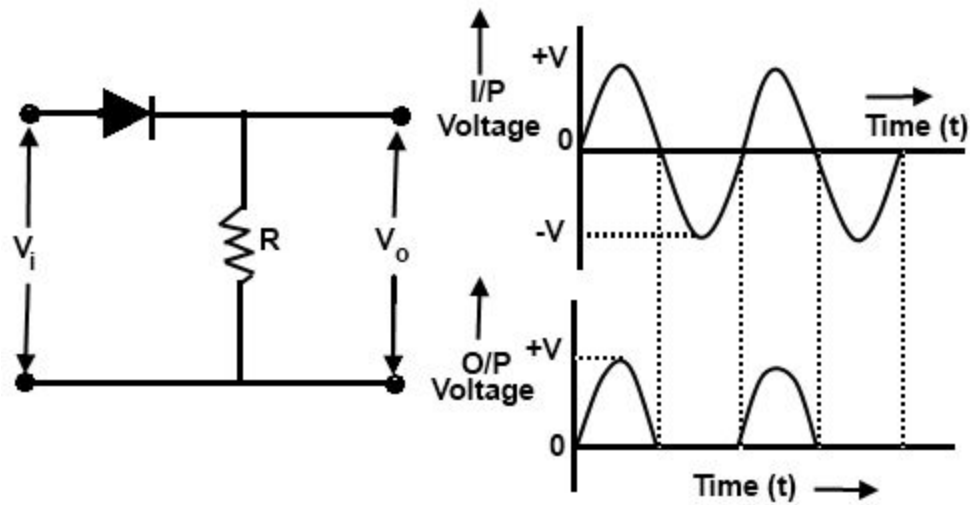


(a) Positive biased

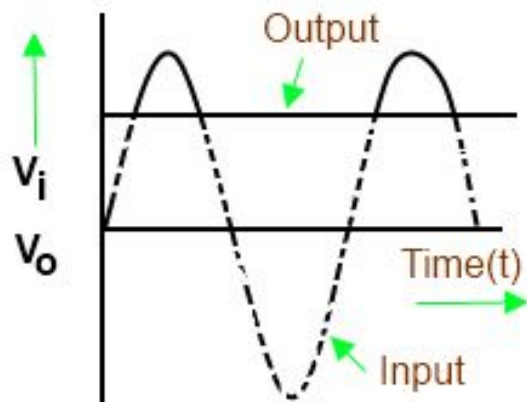
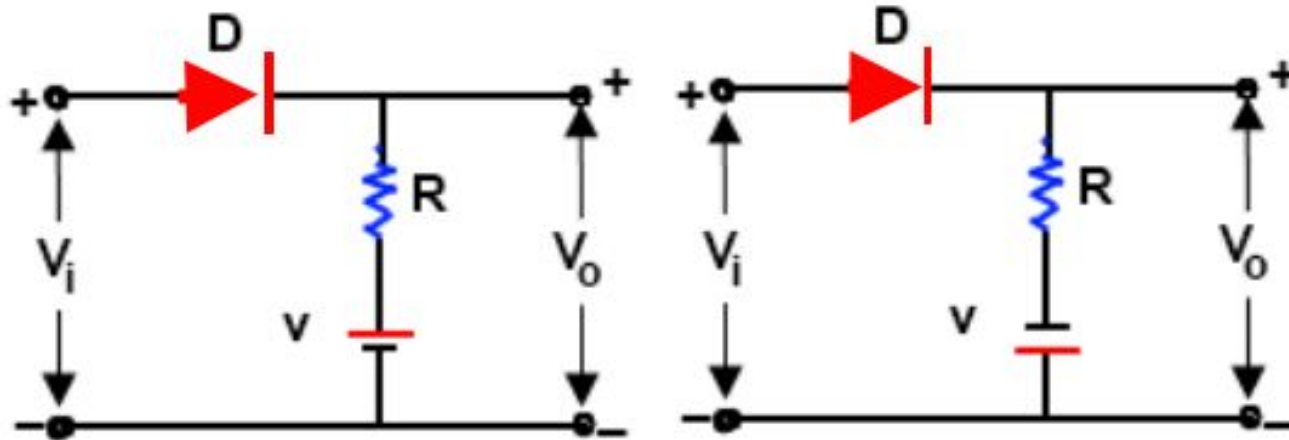


(b) Negative Biased

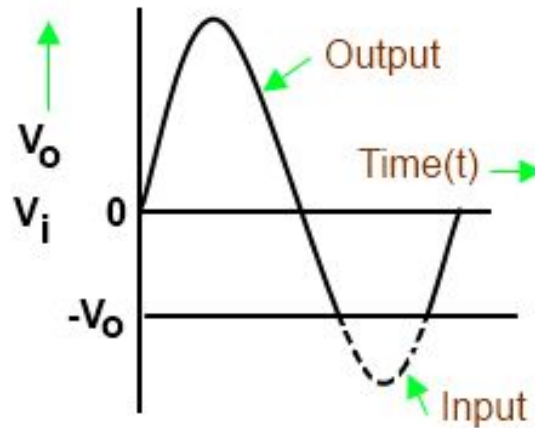
# SERIES NEGATIVE CLIPPER



# SERIES-NEGATIVE CLIPPER WITH BIAS

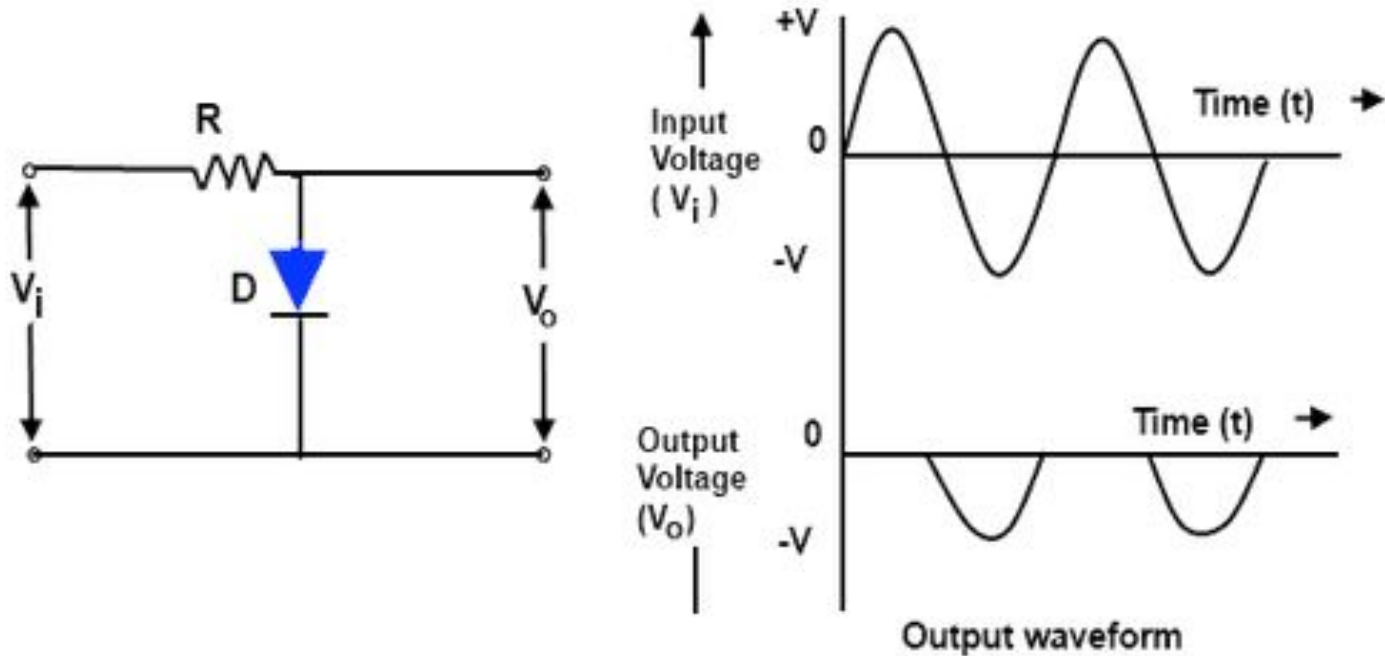


(a) Positive biased



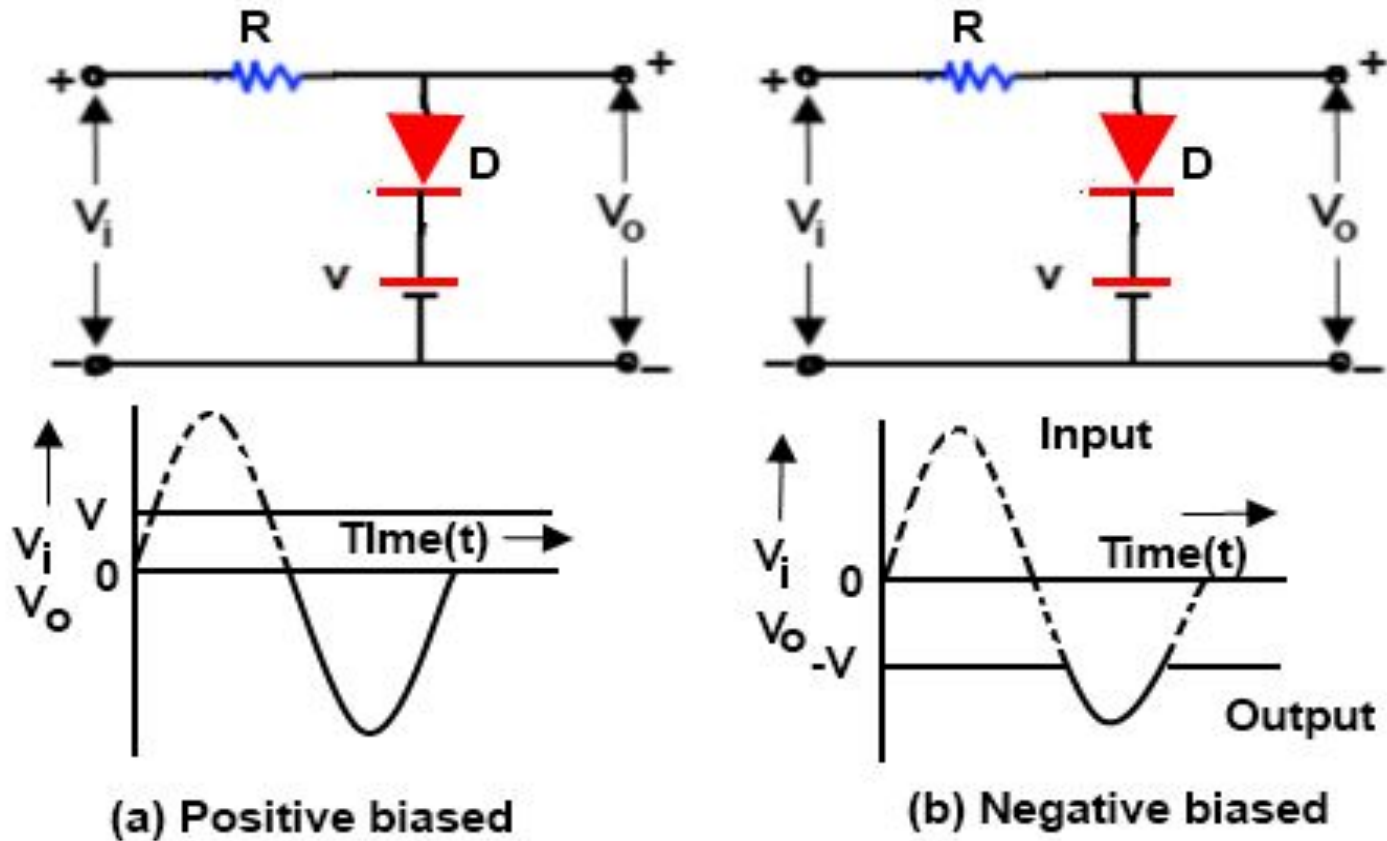
(b) Negative biased

# SHUNT OR PARALLEL POSITIVE CLIPPER

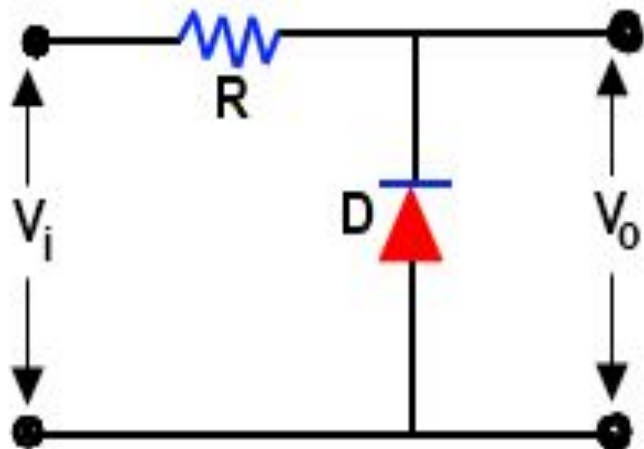




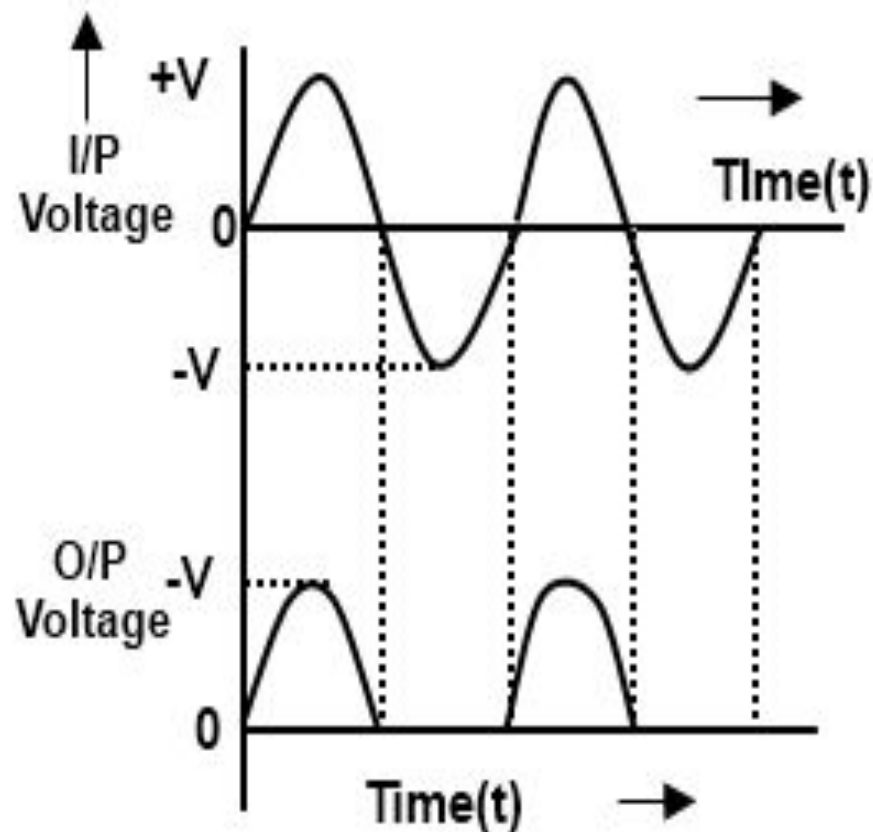
# SHUNT OR PARALLEL POSITIVE CLIPPER WITH BIAS



# SHUNT OR PARALLEL NEGATIVE CLIPPER

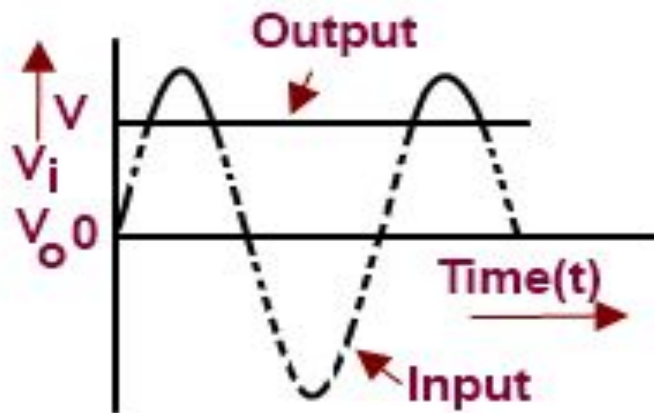
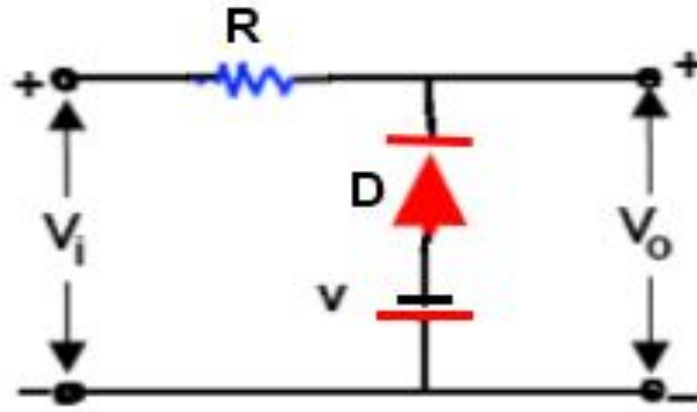
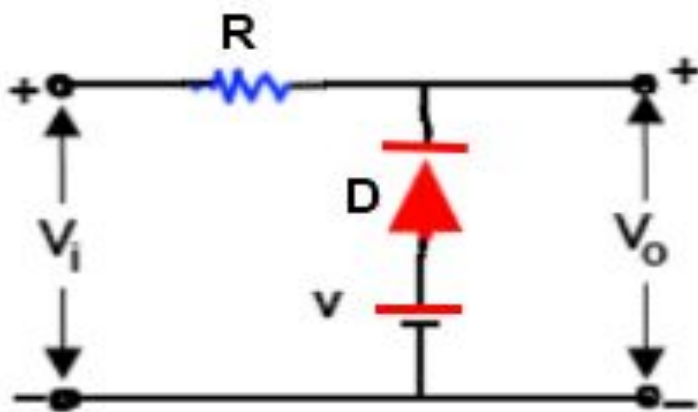


(a)

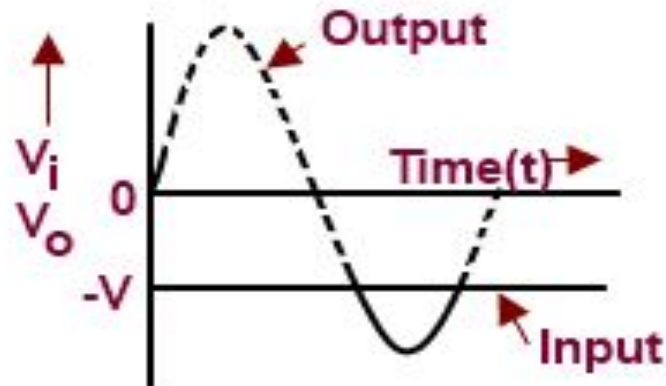


(b)

# SHUNT OR PARALLEL NEGATIVE CLIPPER WITH BIAS

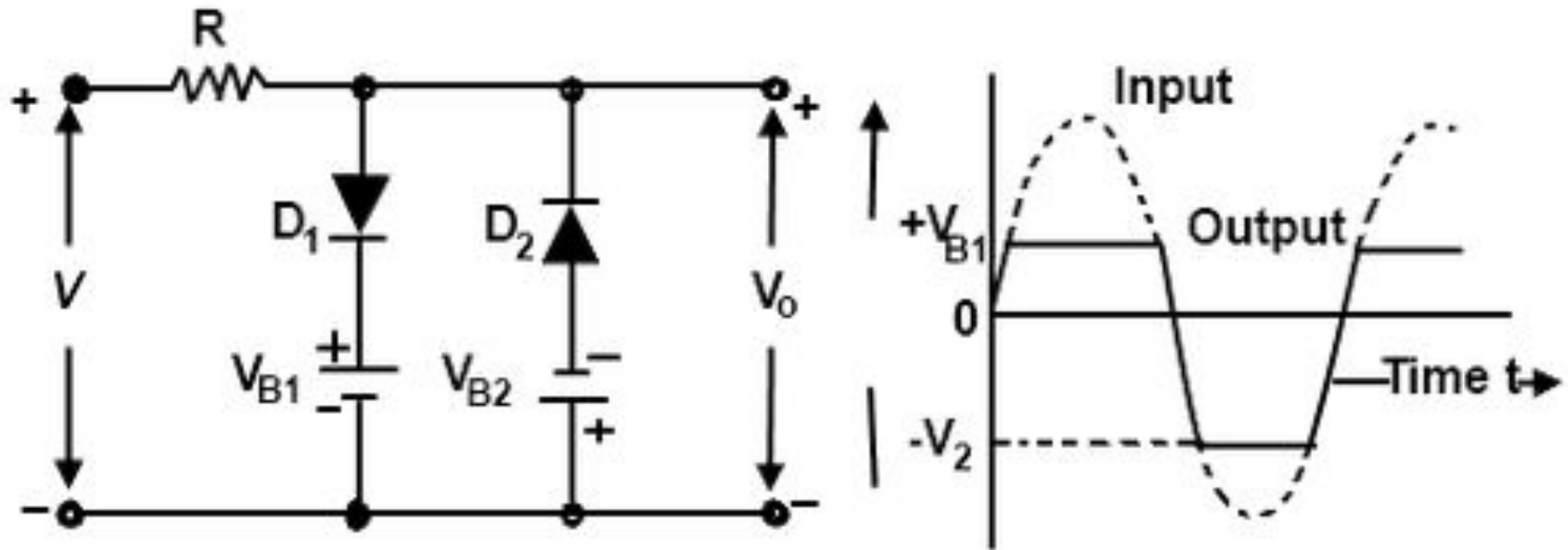


(a) Positive bias



(b) negative bias

# DUAL (COMBINATION) DIODE CLIPPER



# Clipper applications

- Clippers can be used as voltage limiters and amplitude selectors.
- [half wave rectifier](#)
- protection of transistor from transients
- excessive noise spikes above a certain level can be limited or clipped in FM transmitters

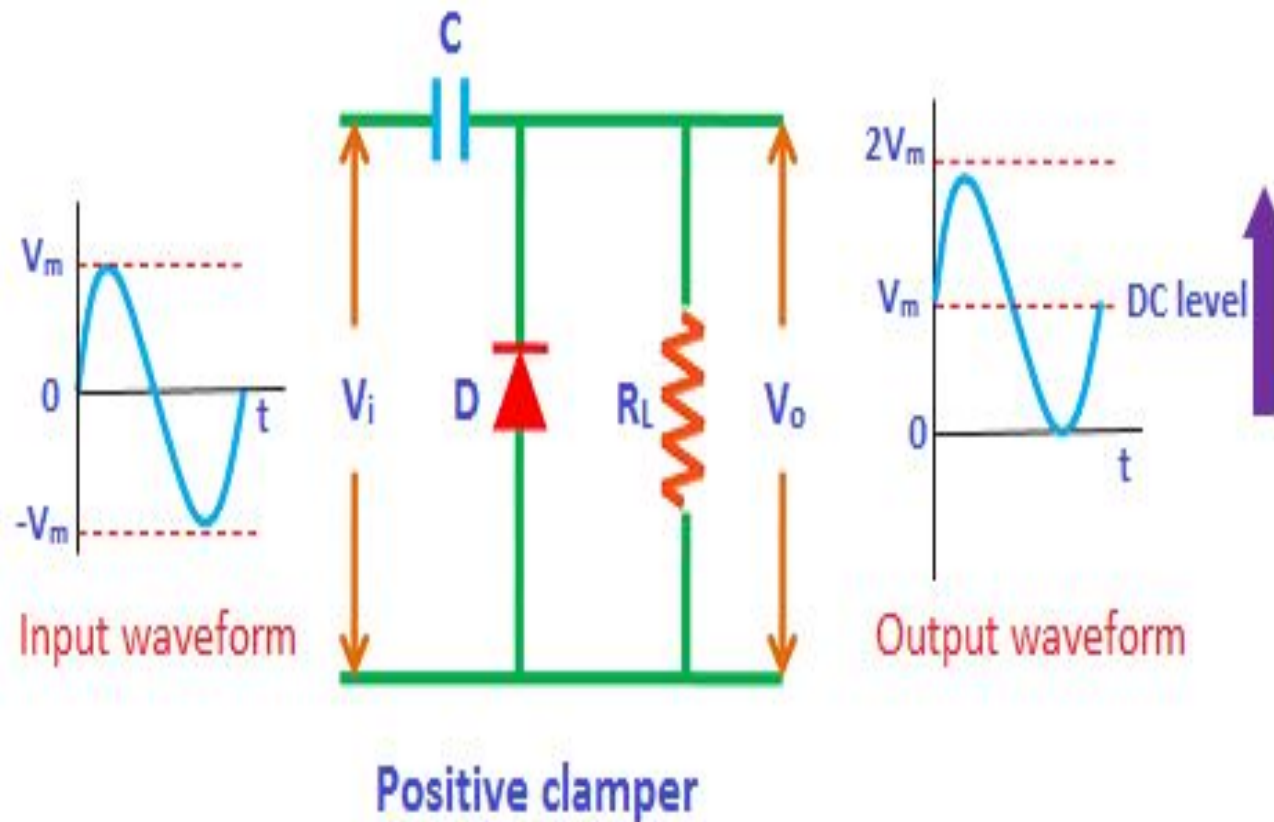
# Clamper circuits

- A circuit that places either the positive or negative peak of a signal at a desired D.C level is known as a clamping circuit.
- A clamping circuit introduces (or restores) a D.C level to an A.C signal.
- Thus a clamping circuit is also known as **D.C restorer**.
- the original signal will not get changed, only there is vertical shift in the signal.

# Types of clampers

- Positive clamper - Positive clamping
- occurs when negative peaks raised or clamped to ground or on the zero level
- In other words, it pushes the signal upwards so that negative peaks fall on the zero level.
- Negative clamper - Negative clamping
- occurs when positive peaks raised or clamped to ground or on the zero level
- In other words, it pushes the signal downwards so that the positive peaks fall on the zero level.

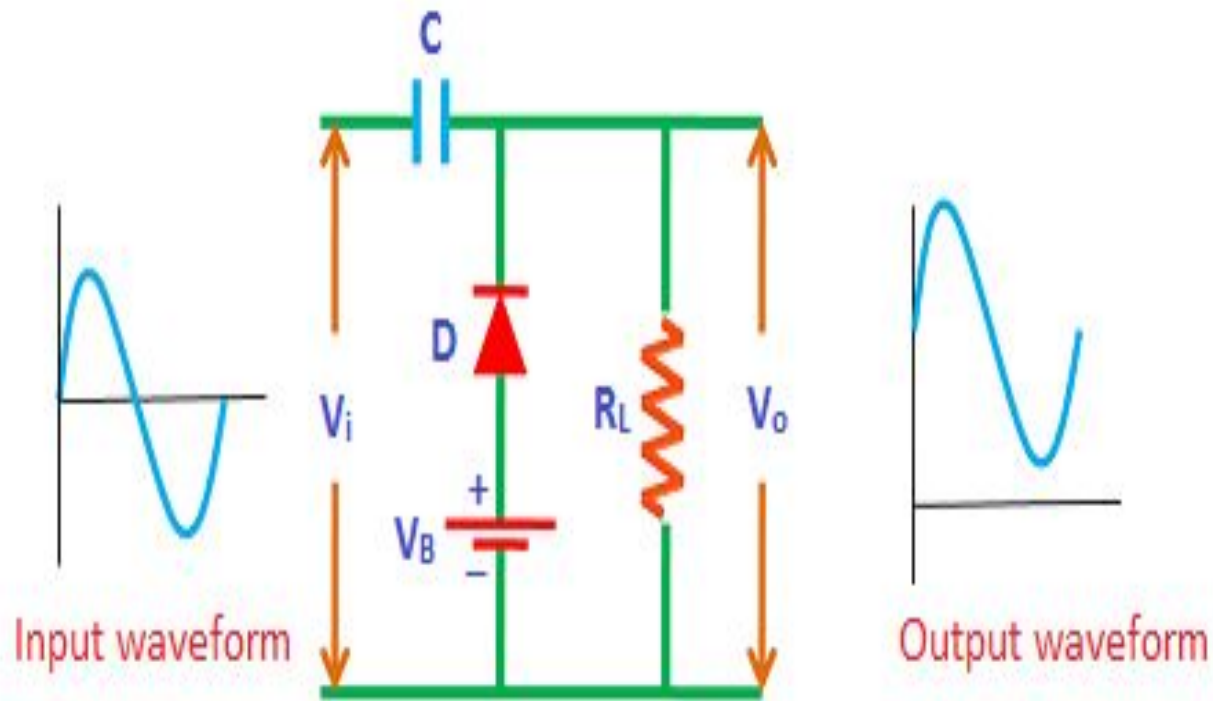
# Positive clamper





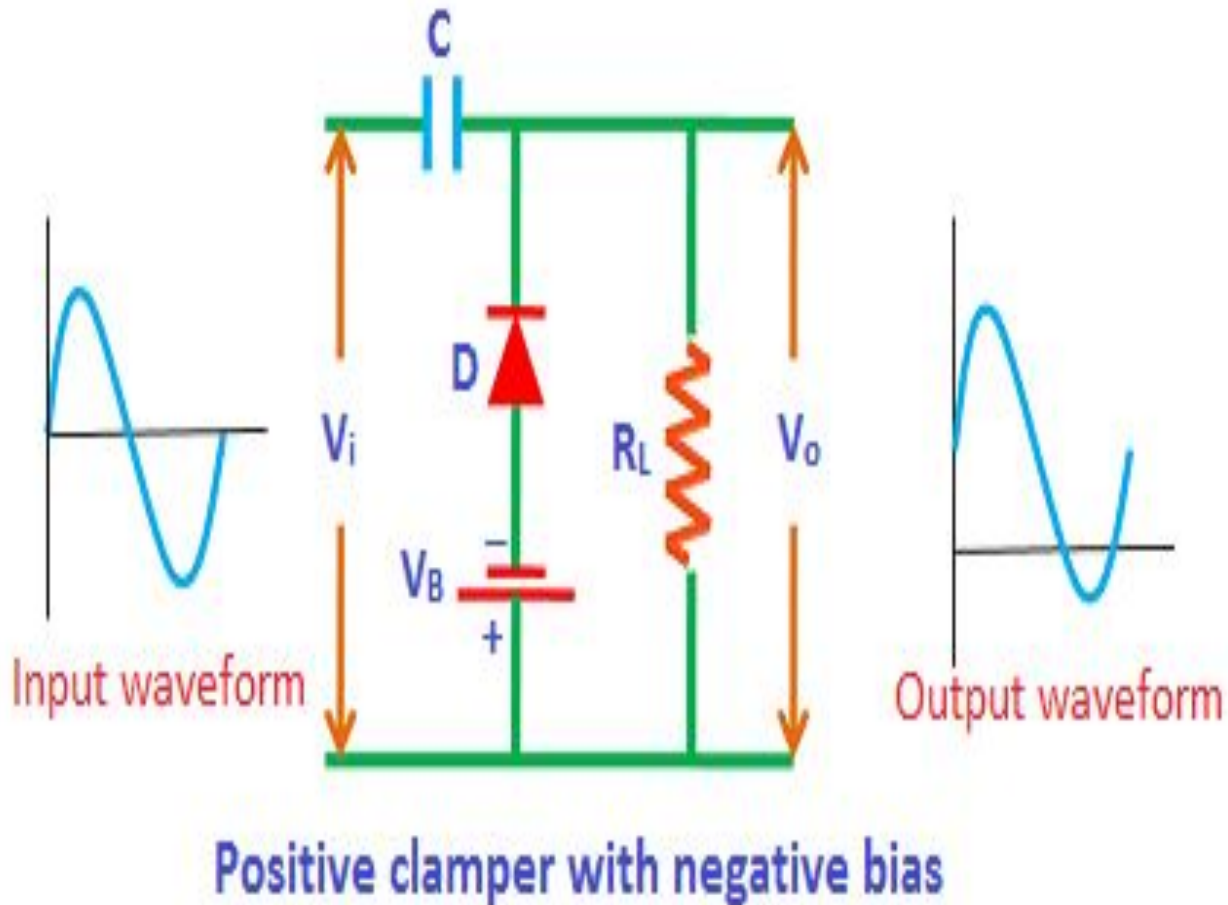
# Positive clamper with positive bias

QUESTION 100% ANSWERED

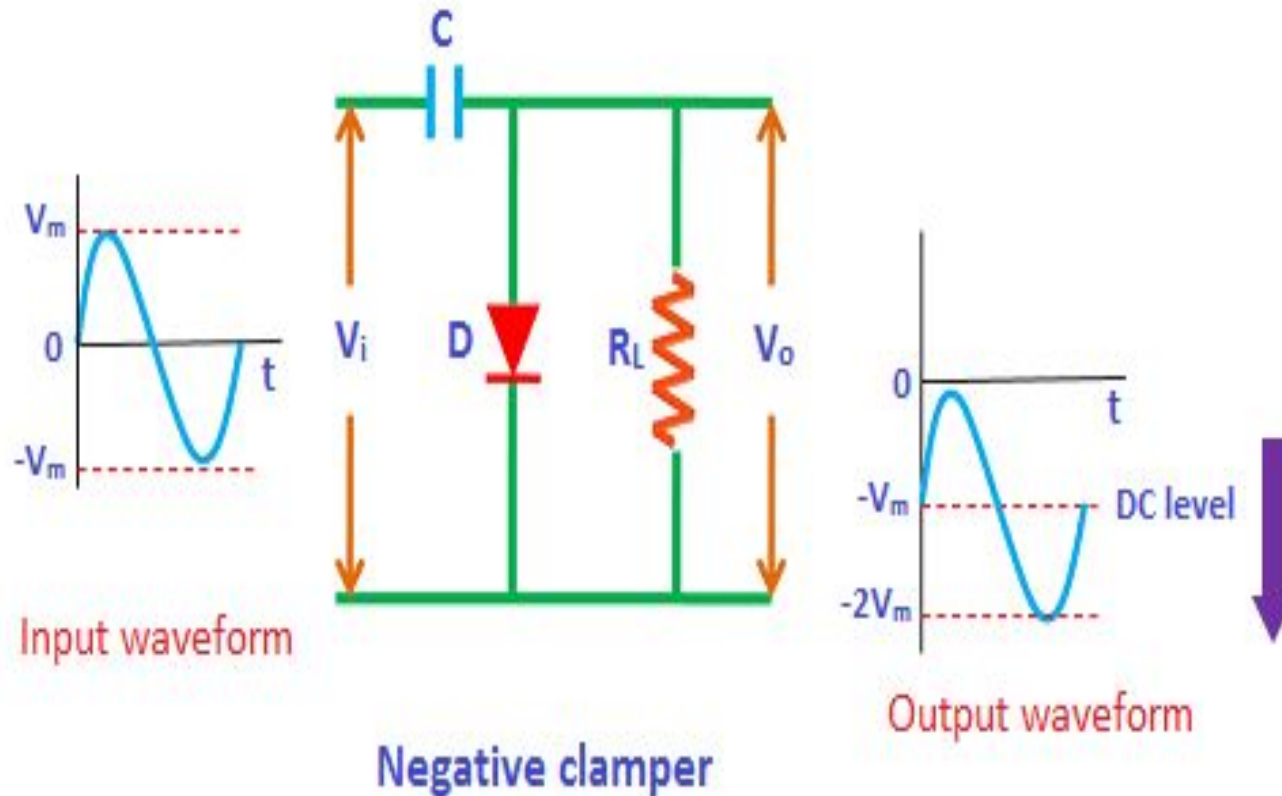


Positive clamper with positive bias

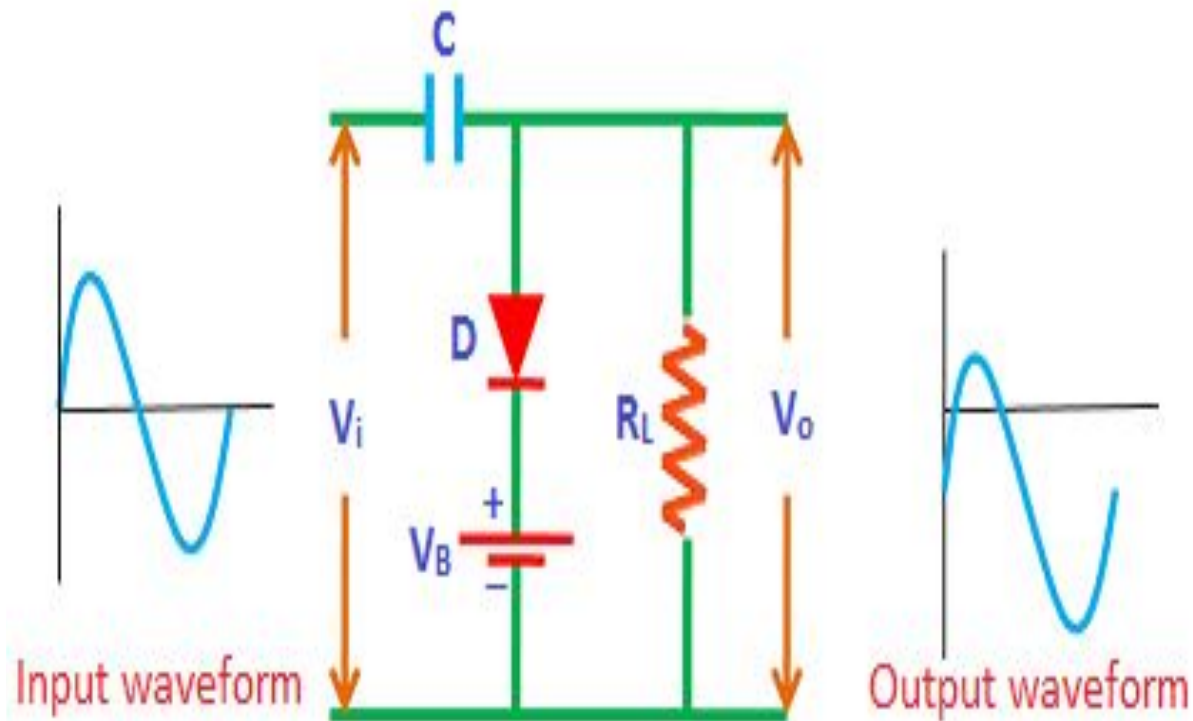
# Positive clamper with negative bias



# Negative clamper

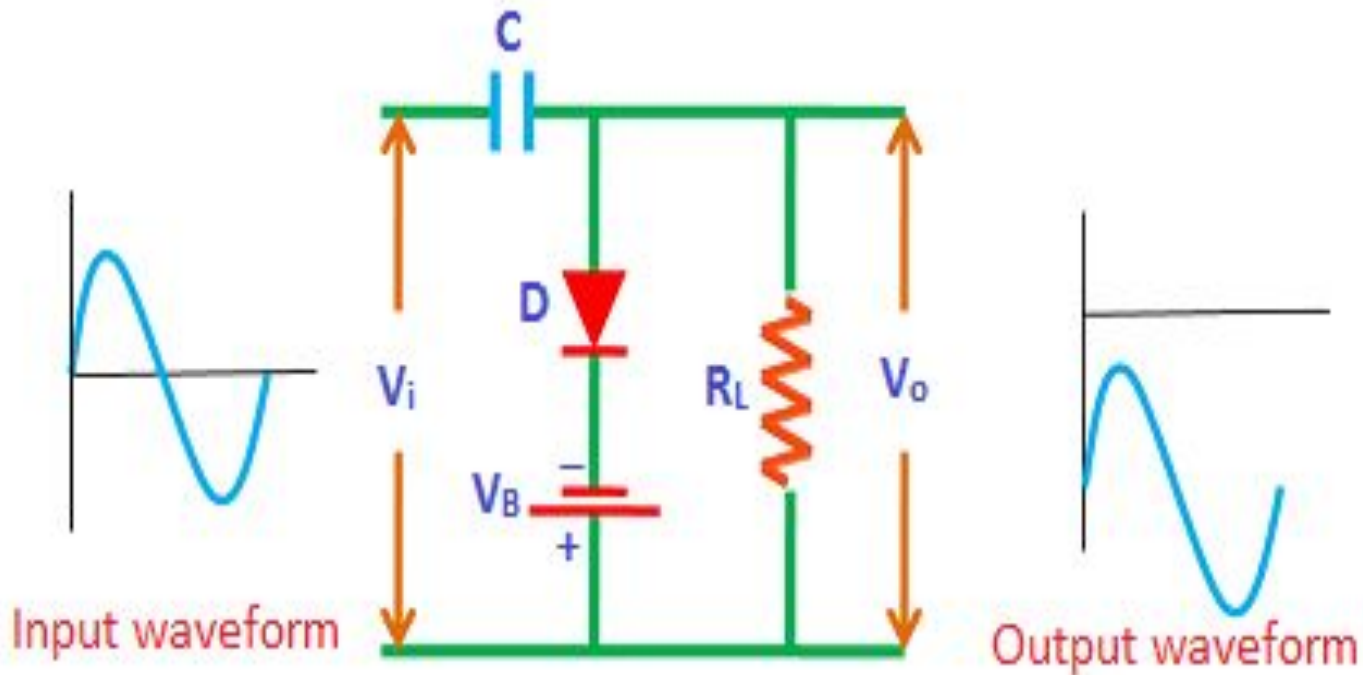


# Negative clamper with positive bias



Negative clamper with positive bias

# Negative clamper with negative bias



Negative clamper with negative bias

# applications

- **Applications of clamping circuits**
- They find some applications in sonar and radar testing
- Used as voltage doublers
- They are used to remove distortions in a circuit
- Used in video processing equipment like TV
- [base line stabilizer](#)