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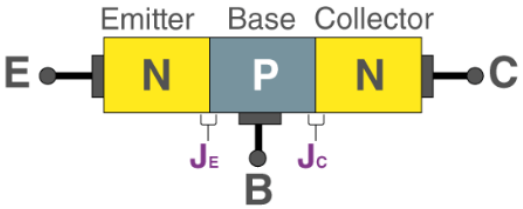
TASK 2

BIPOLAR JUNCTION TRANSISTORS [BJT]

DEFINITION **-**A bipolar junction transistor is a three-terminal semiconductor device that consists of two p-n junctions which are able to amplify or magnify a signal. It is a current controlled device

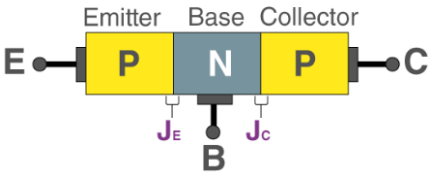


TYPES :

There are two types of bipolar junction transistors:

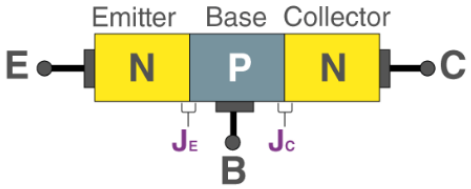
- PNP bipolar junction transistor
- NPN bipolar junction transistor

1] PNP BJT : - In PNP BJT, the n-type semiconductor is sandwiched between the two p-type semiconductors. The two p-type semiconductors act as emitter and collector respectively while the n-type semiconductor acts as a base.



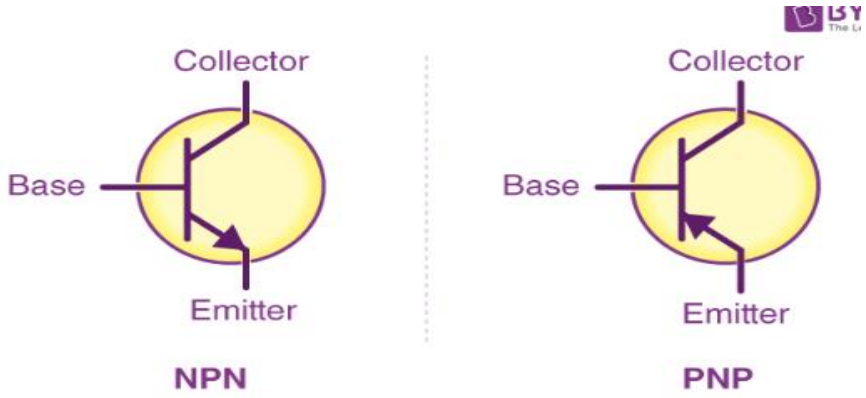
The current enters the transistor through the emitter such that the emitter-base junction is forward biased and the collector-base junction is reverse biased.

2] NPN BJT : -In NPN BJT, p-type semiconductor is sandwiched between the two n-type semiconductors. The two n-type semiconductors act as emitter and collector respectively while the p-type semiconductor acts as a base



Current entering the emitter, base, and collector has the sign convention of positive while the current that leaves the transistor has the sign convention of negative.

FUNCTIONS -



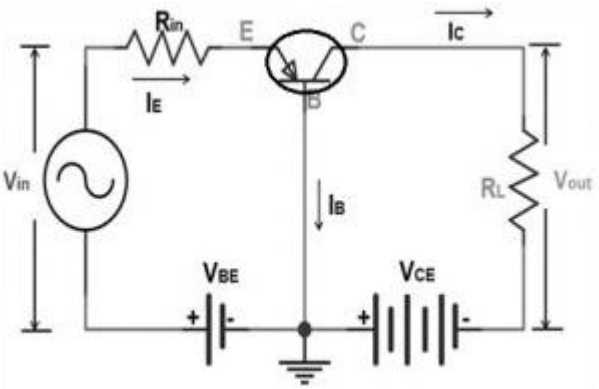
The emitter region is highly doped when compared to other layers. Both collector and base layers have the same charge carrier concentrations. Among these junctions, the base-emitter junction is forward biased, and the base-collector junction is reverse biased. Forward biased means p-doped region has more potential than the n-doped side.

WORKING :

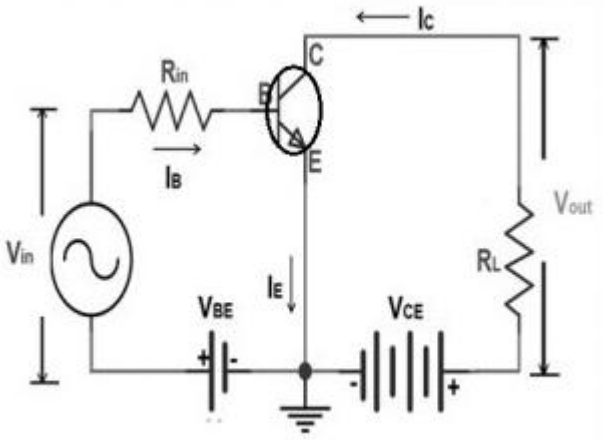
BJT has three configurations having different applications, as follows

- Common Emitter Configuration – has both voltage and current gain
- The common Collector Configuration – has no voltage gain but has a current gain
- The common base configuration – has no current gain but has a voltage gain

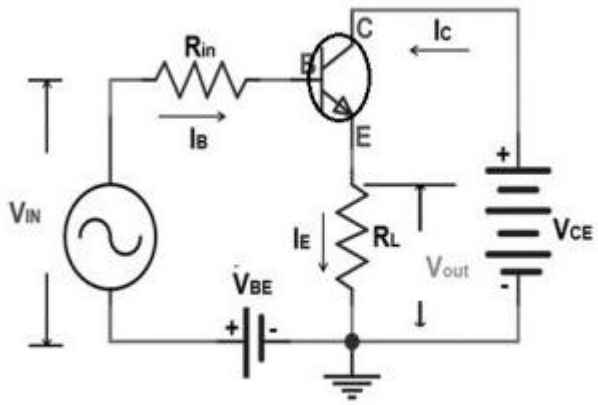
Characteristics	Common Base	Common Emitter	Common Collector
Power Gain	low	Very high	medium
Current gain	low	medium	high
Voltage gain	High	Medium	low
Phase angle	0	180	0
Output impedance	Very high	high	low
Input Impedance	Low	medium	high



CB Configuration



CE Configuration



CC Configuration

ADVANTAGES & DISADVANTAGES OF BJT :

- ***Advantages of BJT***

The main advantages of bipolar junction transistors include the following.

- High driving capability
- High-frequency operation
- The digital logic family has an emitter-coupled logic used in BJTs as a digital – switch.
- It has a high gain bandwidth
- It gives good performance at high frequency
- Voltage gain is good
- It operates in low power or high- power applications
- It includes maximum current density.
- Forward voltage drop is low.

Disadvantages

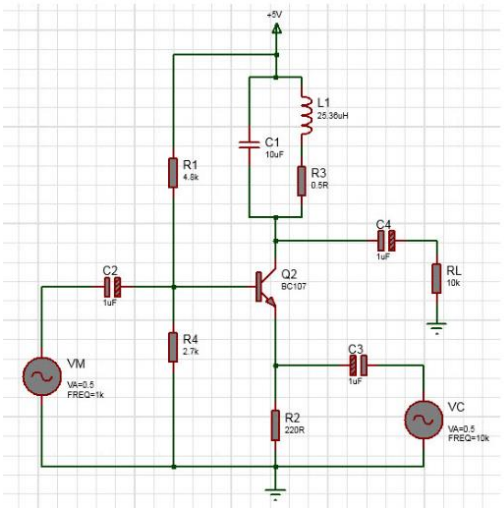
The main disadvantages of bipolar junction transistors include the following.

- Thermal stability is less

- It generates more noise
- The BJT is more an effect of radiation.
- Less switching frequency
- Base control is complex so needs skillful handling.
- The time taken for switching is not fast as compared to a high flashing frequency of voltage & current.

APPLICATIONS : -

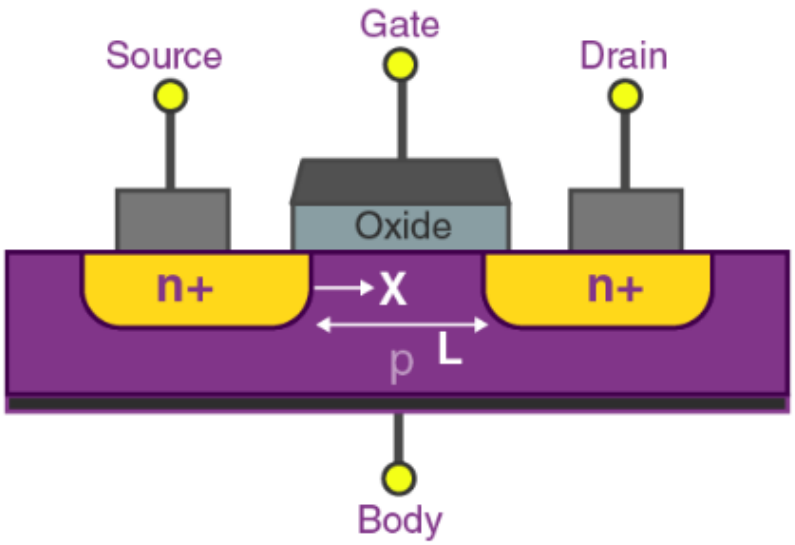
- frequency modulating signal is embedded into high frequency carrier signa
    - ***Switching*** : -A bipolar transistor can be used for switching or amplification by allowing a tiny current to be injected at one of its terminals and controlling a much greater current flowing between two other terminals
    - ***Amplification***: -. To work BJT as an amplifier it should operate in the active or linear regions.
    - ***Automatic switch*** : - A bipolar junction transistor (BJT) can act as an automatic switch in cut-off and saturation modes. In cut-off mode, the transistor is off.
    - In saturation mode, the transistor is on.
    - ***Temperature sensors*** :To use a BJT as a temperature sensor, the collector and base are connected together to form a diode. The simplest way to use a diode is to feed it a constant current. Then the voltage across the diode is translated to temperature
    - ***Demodulator and modulator*** : - AM modulation circuit is a circuit in which a modulating signal amplitude varies the carrier wave amplitude. This is used in wireless AM transmitter where low l.



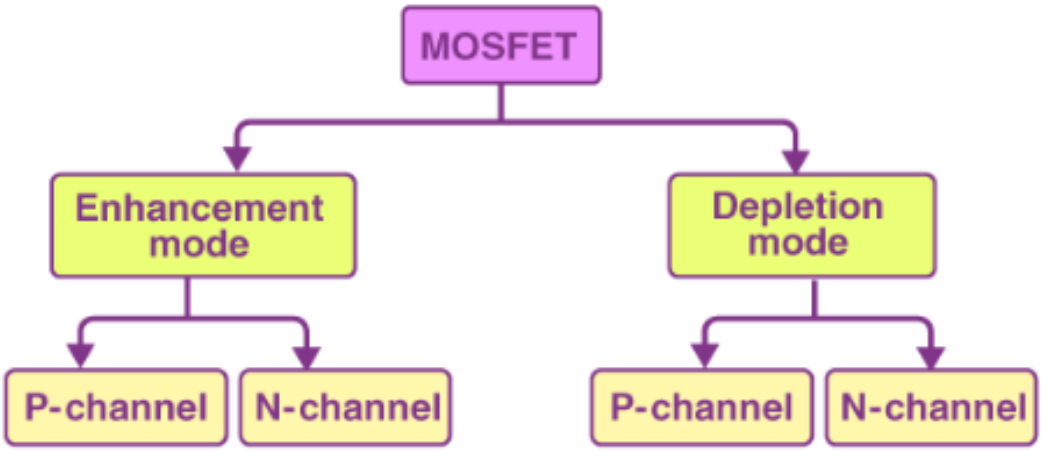
- ***Oscillation circuit***

MOSFET

Definition : Metal Oxide Silicon Field Effect Transistors commonly known as MOSFETs are electronic devices used to switch or amplify voltages in circuits. It is a voltage -controlled device and is constructed by three terminals.



MOSFET Types :



1] ***Depletion Mode :*** When there is no voltage across the gate terminal, the channel shows maximum conductance. When the voltage across the gate terminal is either positive or negative, then the channel conductivity decreases.

2] ***Enhancement Mode*** **:**When there is no voltage across the gate terminal, then the device does not conduct. When there is the maximum voltage across the gate terminal, then the device shows enhanced conductivity.

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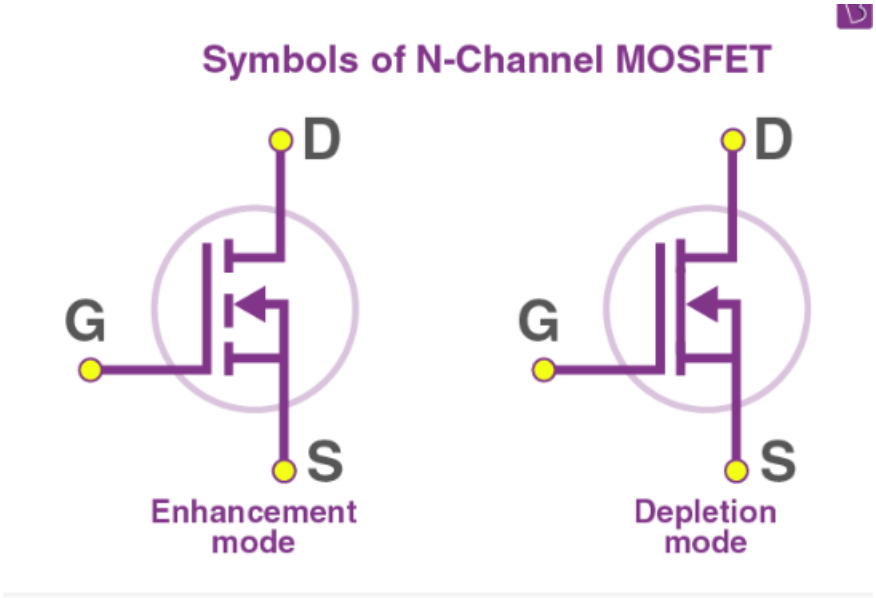
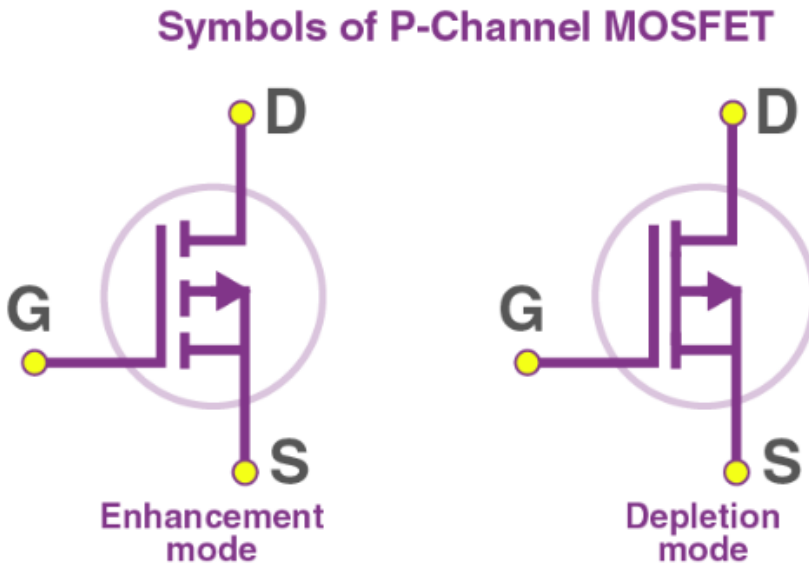
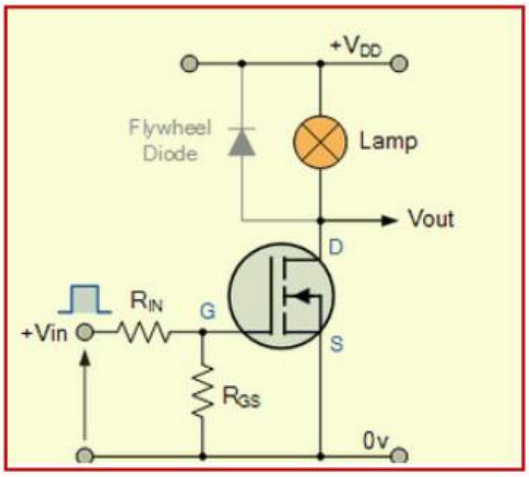


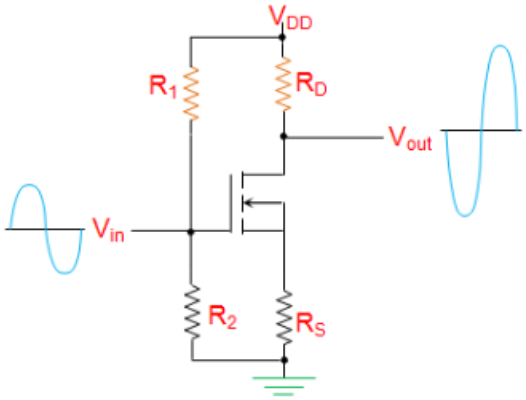


APPLICATIONS :

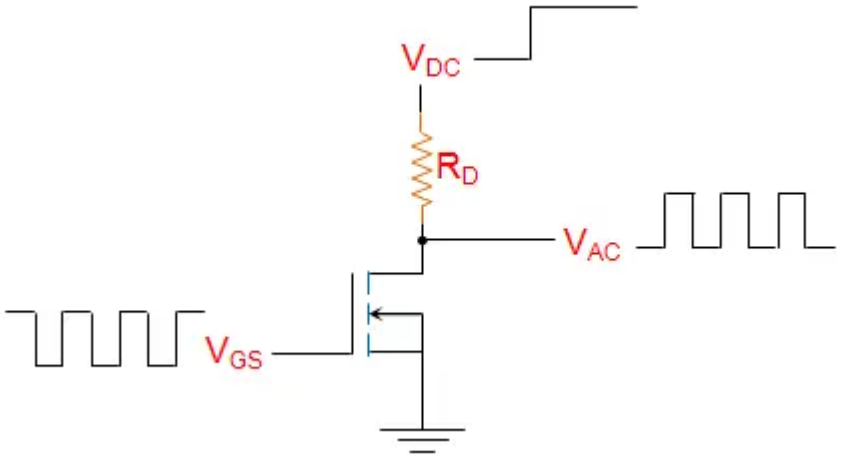
1. ***MOSFET As a Switch*** : Enhancement type of mosfet is used for this kind of application. The voltage is applied at the gate of the MOSFET at that condition the lamp is ON. When the zero voltage level is applied at the gate then the device and lamp is turned off (VGS=0. So by this way, we can use MOSFET for switching operation. And MOSFET has a very high switching device.



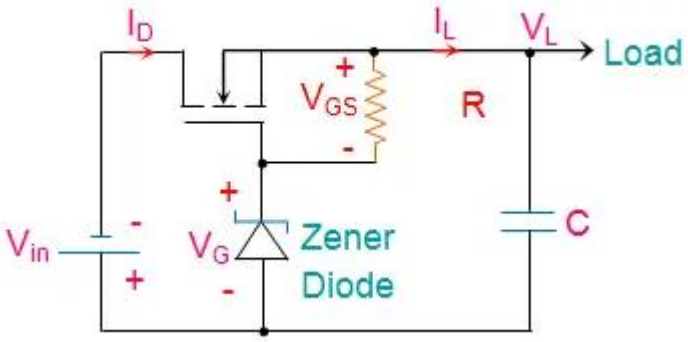
2. ***MOSFET as a Amplifier*** : - We use Ehancement Type of MOSFET. For a good amplifying signal we must require to get an operating point for that circuit. Here input signal is applied between gate (G) and source (S) to generate require gate signal for getting an operating point.An outputt is taken between the drain (D) and source (S).



3. .***MOSFET IN CHOPPER CIRCUIT*** : - Chopper circuits that chop or modulate a DC voltage into an AC voltage with variable frequency and amplitude. A MOSFET can be used as a chopper to control the duty cycle of a square wave applied to a transformer or an LC circuit, which changes its output characteristics.Hereby chopper D.C signal is converted into an A.C signal.



4. ***MOSFET used in voltage regulator circuits*** : -Linear voltage regulator circuits that maintain a constant output voltage despite variations in input voltage or load current. A depletion-mode MOSFET can be used as a linear voltage regulator to act as a variable resistor in series with the load, which adjusts its resistance according to the load current.



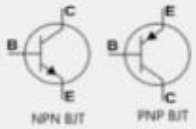
5. ***Digital Circuits*** : A MOSFET can be used as a digital circuit element to implement logic functions by using its switching behavior.

6. ***MOSFET in Microprocessor*** : - These are integrated circuits that perform arithmetic and logic operations on data using instructions stored in memory. A microprocessor consists of millions of transistors arranged in complex architectures that execute various tasks. A MOSFET is one of the main types of transistors used in microprocessors due to its high density, low power consumption, and fast speed.

Conclusion

MOSFETs are versatile devices that have many applications in electronics and technology. They can act as switches or amplifiers depending on their operation mode and biasing conditions. They can also perform various functions such as chopping, regulating, sensing, processing, etc., depending on their circuit configuration and design. They are widely used in power electronics, analog electronics, digital electronics, microprocessors, and many other fields due to their advantages, such as high switching speed, low power consumption, high input impedance, high efficiency, and simple structure.

Difference between BJT and MOSFET

PROPERTIES	BIPOLAR JUNCTION TRANSISTOR (BJT)	METAL OXIDE SEMICONDUCTOR FIELD EFFECT TRANSISTORS (MOSFET)
Classification	There are two types of bipolar junction transistors: NPN and PNP.	MOSFETs are categorized into enhancement MOSFET (p channel and n channel) and depletion MOSFET (p channel and n channel).
Terminals	Base, emitter and collector	Gate, source and drain
Symbol		
Transistor type	Bipolar transistor	Unipolar transistor
Charge carriers	Both electrons and holes acts as charge carries in BJT.	Either electrons or holes acts as charge carrier.
Control method	A BJT is a currect controlled device.	A MOSFET is a voltage controlled device.
Switching speed	The maximum switch speed of a bipolar junction transistor is	The maximum switching frequency is 300KHz.

Input Impedance	Low	High
Output Impedance	Low	Medium
Temperature coefficient and paralleling	BJTs have negative temperature coefficient that limits their parallel operation.	MOSFETs have positive temperature coefficient and can be easily paralleled.
Power consumption	Since BJT is a current controlled device, it consumes more power than voltage-controlled devices like MOSFET.	A MOSFET Consumes less power than a BJT.
Second breakdown limit	A BJT has a second breakdown limit.	A MOSFET has a safe operating area similar to BJT but does not have a second breakdown limit.
Applications	BJTs are much suitable for amplifiers, oscillators and switching of circuits with constant current flow.	MOSFETs are suitable for power supplies and high-frequency low voltage applications.

ADVANTAGE OF MOSFET OVER BJT :

• Speed: MOSFETs are about 10 times faster than BJTs. They consume less power while switching at high frequencies.

• Switching loss: MOSFETs have less switching loss than BJTs.

• Parallel operation: MOSFETs are easier to parallel than BJTs.

• Power consumption: MOSFETs use low power and draw no current.

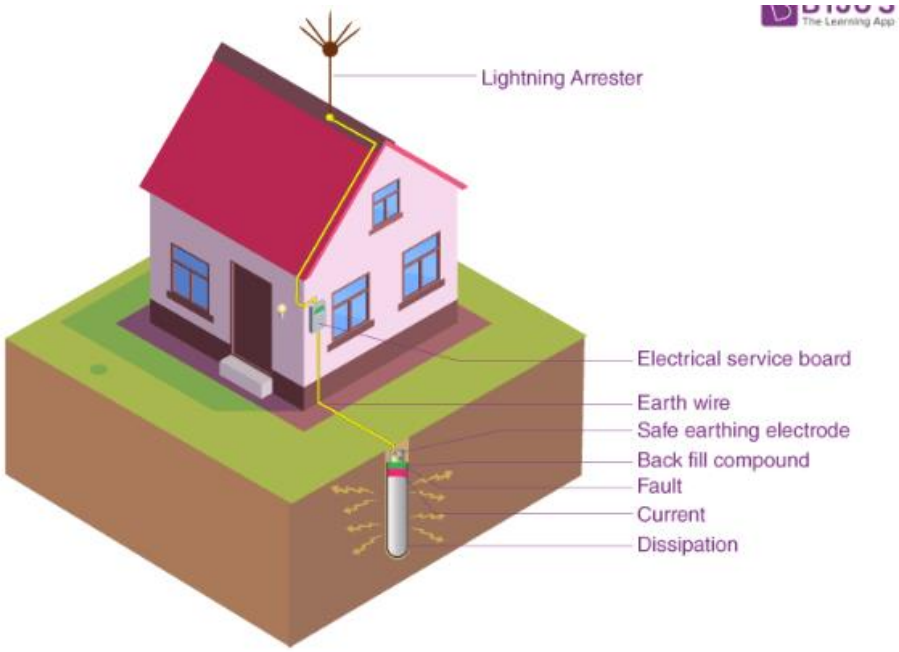
• Input impedance: MOSFETs have high input impedance because they lack gate current.

• Circuits: MOSFETs form the basis of circuits with switches of analog signals.

MOSFETs are voltage-controlled devices, while BJTs are current-controlled. MOSFETs conduct by gate-oxide controlled field-effect

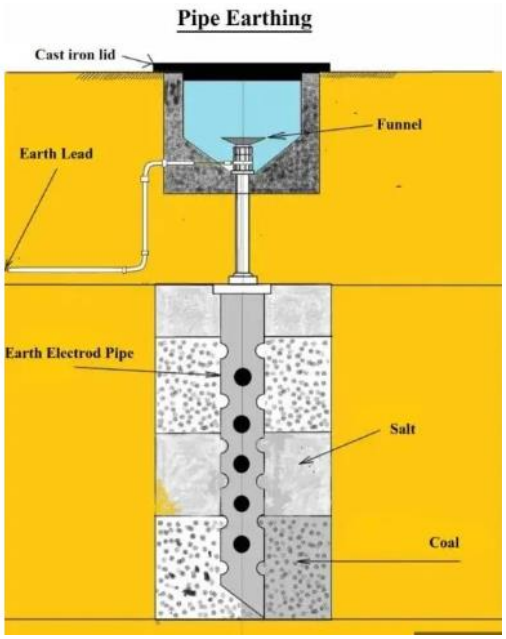
EARTHING

DEFINITION : The process in which the instantaneous discharge of the electrical energy takes place by transferring charges directly to the earth through low resistance wire.

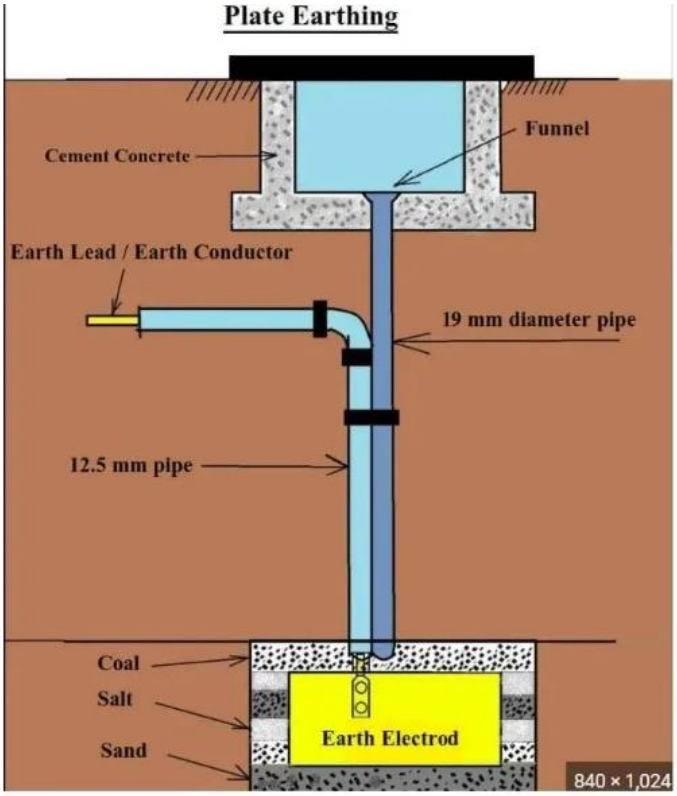


TYPES OF EARTHING :

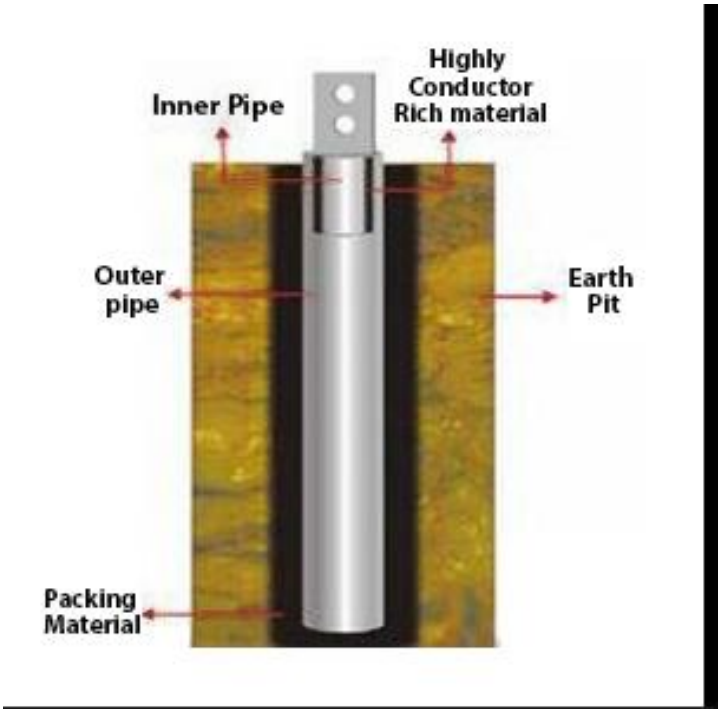
1] Pipe Earthing : Pipe earthing is the best and most efficient way of earthing and is also easily affordable. Pipe earthing uses 38mm diametre and 2 metres length pipe vertically embedded in the ground to work as earth electrodes.



2] Plate Earthing : -The most efficient way of earthing is Plate earthing, which involves installing a galvanized copper plate 3m deep in the earth and connecting it to all conductors. Moreover, an alternative method is to use earthing layers made of salt and coke, which increases conductivity and reduces resistance.



3] **Strip Earthing** : It is mostly used in the transmission of the power supply in this case strip cross-section 25mm X 1.6mm or 25mm X 4mm is made up of Galvanized iron or copper strip. The strip is approximately inside the horizontal trench minimum height is 0.5m required.



GROUNDING

DEFINITION : Ground is a reference point defined by us . This reference point is known as ground (or GND) and carries a voltage of 0V. Voltage measurements are relative measurements. That is, a voltage measurement must be compared to another point in the circuit.

Types of Grounding :

1] Resistance Grounding : -Resistance grounding is when you have a connection between your neutral line and the ground through a resistor. This resistor is used to limit the fault current through your neutral line: if your voltage doesn't change, then your current is dependent on the size of the resistor according to Ohm's law (V=IR).

a. **Low Resistance Grounding** : It is done through by connecting the neutral to the ground through low resistance .

b. **High Resistance Grounding** : It is suitable for systems that do not need to be isolated immediately after the occurrence of faults. In high resistance grounding , the neutral is grounded through a high resistance so that the current flow to the ground.

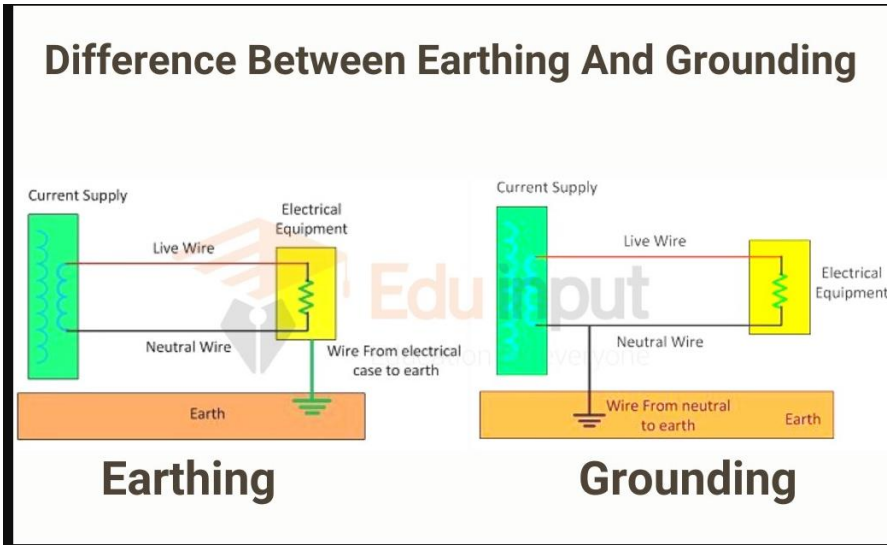
2] Ungrounded Systems : The system in which neutral of transformers and genreators are not grounded is known as an underground system. Even though there is no physical grounding , a capcitive coupling does exist between the line conductors and the ground. Therefore an underground system can also be considered a system grounded by capacitance.

3] Reactance grounded System : -Reactance grounding is achieved by grounding the system through a reactor. Unlike low and high resistance grounding, the ground fault currents in the system of this type shall be higher. Under arcing ground fault situations, this inductive reactance to ground resonates with the system's shunt capacitance to ground and generates extremely high transient over-voltages on the system.

4] Resonant grounded system : A resonant grounded system is a system grounded through a variable impedance reactance. A variable impedance reactance is connected between the transformer neutral and the ground. This reactor compensates for the line-to-ground capacitance such that the zero-sequence network becomes a very high impedance path. In a resonant grounded system, most of the ground faults can be cleared without circuit breaker tripping. This can be applied to high voltage transmission and generation stations.

	Ground fault current (% of 3phase fault current)	Transient overvoltages	Surge Arresters	Remarks
Ungrounded system	Below 1%	Very high	Ungrounded neutral type.	Not recommended due to overvoltage.
Solid grounding	Could be 100% or even higher	Not Excessive	Grounded neutral type.	Used for systems over 15kV and below 600V.
Low resistance grounding	20% and downwards to 100A to 1000A	Not Excessive	Ungrounded neutral type.	Generally used for 2.4kV to 15kV systems with motor loads.
High resistance grounding	Below 1%	Not Excessive	Ungrounded neutral type.	Used for systems below 600V where operation continuity is the priority.
Low reactance grounding	Between 25% and 100%	Not Excessive	Grounded neutral if the current exceeds 60%.	Used for systems over 15kV and below 600V.
High reactance grounding	Between 5% and 25%	Not Excessive	Ungrounded neutral type.	Not recommended due to overvoltage.
Resonant grounding	Close to zero.	Not Excessive	Ungrounded neutral type.	Best suited for all medium voltage and commercial applications.

DIFFERENCE BETWEEN GROUNDING & EARTHING



S.No	Installation earthing	System Grounding
1	Earthing means connecting the dead part (it means the part which does not carries current under normal condition) to the earth for example electrical equipment's frames, enclosures, supports etc.	Grounding means connecting the live part (it means the part which carries current under normal condition) to the earth for example neutral of transformer.
2	It is equipment earthing.	It is source or system earthing.
3	Earthing is an alternate low resistance path for leakage current.	Grounding is a source for unwanted currents and also as a return path for main current for protection of delicate equipments.
4	The purpose of earthing is to minimize risk of receiving an electric shock if touching metal parts when a leakage current is present.	Grounding is done for the protections of power system equipment and to provide an effective return path.
5	The purpose of earthing is to minimize risk of receiving an electric shock to human.	It is provided for eliminating arcing ground and over voltage surge.
6	Generally Green wire is used for this as a nomenclature.	Generally Black wire is used for this as a nomenclature.
7	EEarthing connections are of four types: • Plate earthing • Pipe earthing • Rod earthing • Strip earthing	E Grounding connections are of three types: • Solid earthing • Resistance earthing • Reactance earthing
8	It is nothing to do with the system stability.	It increases stability of the system.
9	It does not provide any means for protection system against earth fault.	This earthing provides suitable means for earth fault protecting system.

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