1. FIELD EFFECT TRANSISTOR (FET)

- FET is a three terminal semiconductor device. It is unipolar transistor i.e. depends only on one type of charge carrier, either electron or hole.

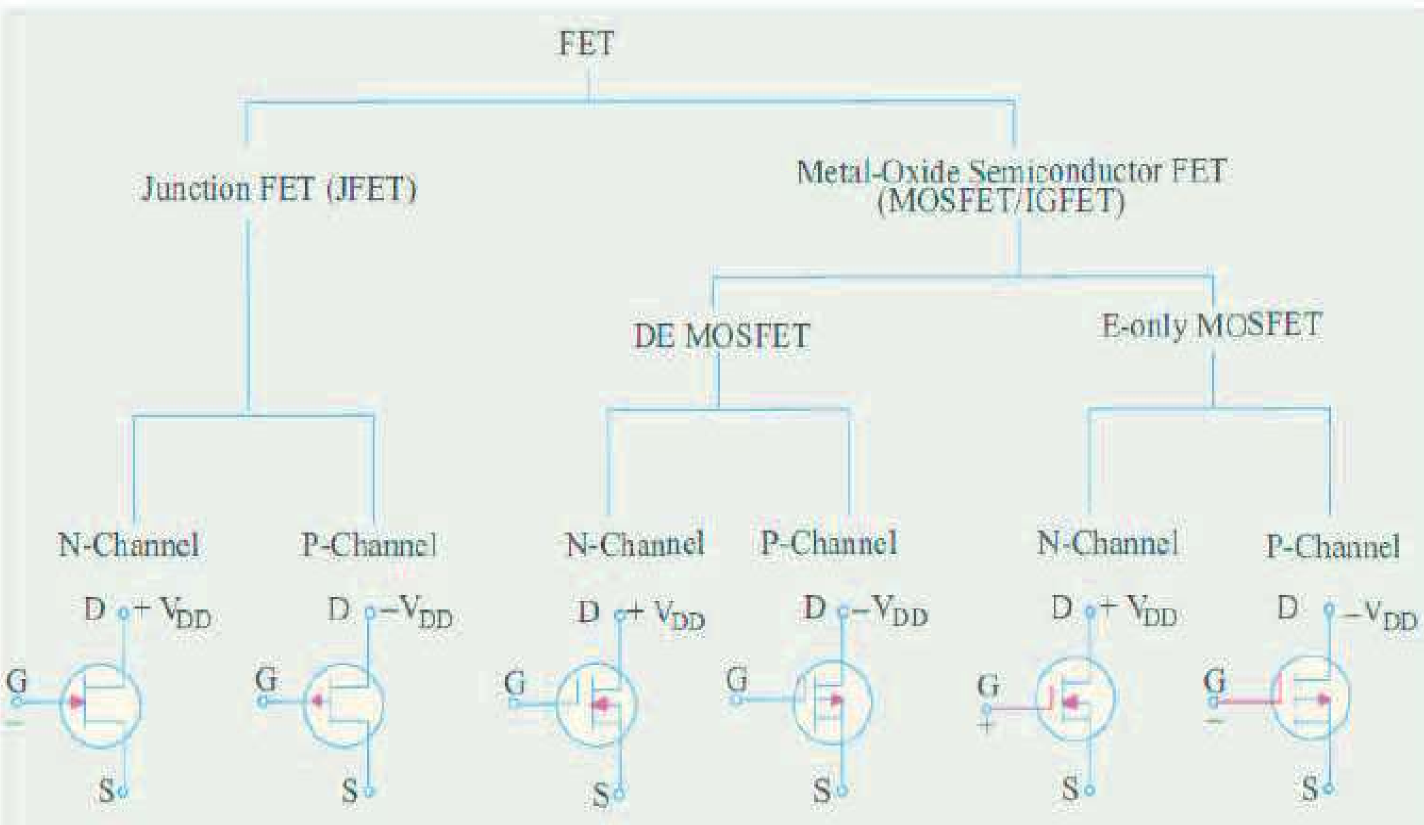
- The current is controlled by the applied electric field hence, it is a voltage controlled device.

- FET is simple to fabricate and occupies less space on a chip than a BJT. About 100000 FETs can be fabricated in a single chip. This makes them useful in VLSI (very large scale integrate) system.

- It have high input Impedances and Low output Impedance so they are used as buffers at the front end of voltage and other measuring devices.

- It has small coupling capacitances, as a result, they are used in hearing aids.

- There are two types of FET – the JFET (Junction Field Effect Transistor) and MOSFET (Metal Oxide Semiconductor Field Effect Transistor)


FET
Junction FET (JFET)
Metal-Oxide Semiconductor FET
(MOSFET/IGFET)
DE MOSFET
E-only MOSFET
N-Channel
P-Channel
N-Channel
P-Channel
N-Channel
P-Channel
D + V_{DD}
G
S
D $-V_{DD}$
G
S
D + V_{DD}
G
S
D $-V_{DD}$
G
S
D + V_{DD}
G
S
D $-V_{DD}$
G
S

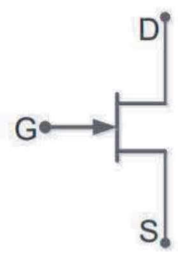
2. Junction Field Effect Transistor (JFET)

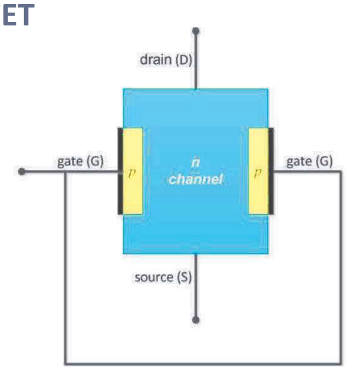
- It is of two types
  - ❑P-channel JFET
  - ❑n-channel JFET

- The n- channel JFET consists of a bar of n-type semiconductor with two islands of p- type material embedded in the sides. The drain and source terminals are made by ohmic contacts at the end of p-type of semiconductor bar . Majority charge carrier i.e. electrons can be cause to flow along length of bar by means of a voltage applied between the source and drain .The electrons leave from drain the third terminal, known as the gate is formed by electrically connecting the two p-type regions

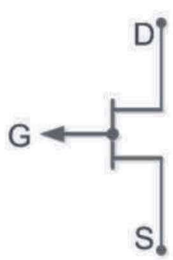
- The circuit symbol of p- channel JFET is similar to that of an n-channel JFET except that the gate arrow points outward as shown in below.

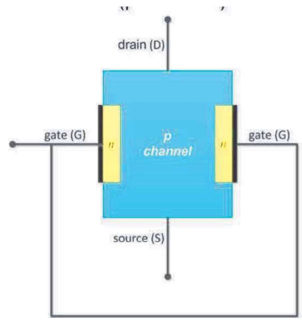
- **Symbol & Structure of n-channel JFET**





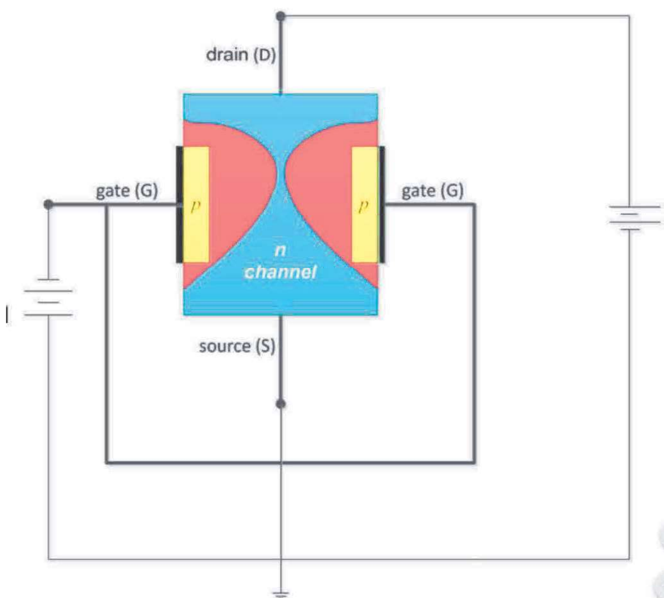
- **Symbol & Structure of p-channel JFET**

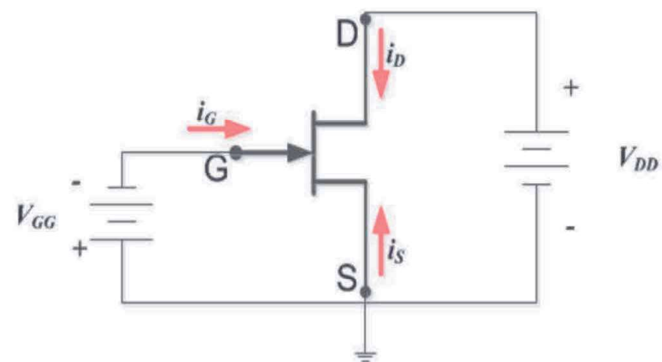




2.1 JFET Operation and Circuit analysis

- **Figure shows an n-channel JFET in the common source configuration showing the depletion region**





2.1 JFET Operation

- The Gate and channel constitute a PN junction diode which is reverse biased by the gate to the source voltage.

- A depletion layer is developed in the channel as reverse bias increases the width of depletion layer increases.

- For a fixed drain to source voltage, the drain current will be a function of reverse bias voltage across the gate junction.

- At a gate-to-source voltage $V_{GS}=V_p$ known as the "Pinch- off" voltage which eliminates the channel, the channel width is reduces to zero.

- The term Field Effect is used to describe this device because of mechanism to control current using reverse bias voltage $V_{GS.}$

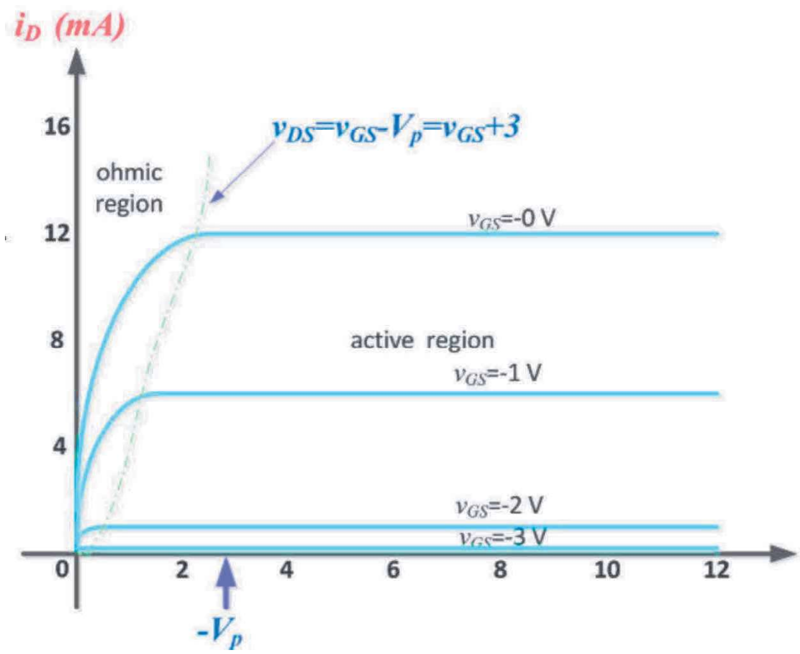
2.2 Drain characteristics

I_{DSS}= 12mA and pinch off voltage is Vp= -3V.

If v_{GS}=0 V, channel pinch off when v_{DS}= - V_p=3V

If v_{GS} =-1V, channel pinch off at $v_{DS} = v_{GS} - V_p = -1+3=2V$

The dashed curve is corresponding to $v_{DS} = v_{GS} - V_p$ To the right of this curve , ($v_{DS} > v_{GS} - V_p$), The channel is pinched off and this region is called as pinch off region or **saturation region**.
(active region). To the left of this curve, ($v_{DS} < v_{GS} - V_p$), the channel is not pinched off and the region is called as **ohmic region**.
When the gate is sufficiently reverse biased , channel will be totally eliminated for $v_{GS} < V_p$, under this circumstances increasing v_{DS}, will not be sufficient to produce a drain current. i_D=0 and JFET is said to be in cutoff.



Important Parameters of JFET

- Transconductance (g_m) :It is given by $g_m = (I_d/V_{GS})\Big|_{V_{DS}}$

i.e. It is the ratio of change in drain current to the change in gate source voltage at constant drain source voltage.

- Output resistance (r_d):It is given by $r_d = (V_{DS}/I_d)\Big|_{V_{GS}}$

i.e. It is the ratio of change in AC drain source voltage to the change in AC drain current at constant gate source voltage

- Amplification factor(❍):It is defined as ❍ = $(-V_{DS}/V_{GS})\Big|_{I_D}$

i.e. It is the change in the AC drain-voltage

2.3 Comparison Between FET and BJT

FET	BJT
i) Carriers of only one type i.e either electron or hole (majority carrier) are responsible for the conduction.	i) Carriers- electron and hole (majority and minority carrier)-involved in current conduction
ii) It is the drift mechanism that helps the movement of carriers	ii) The carriers are transported by the process of diffusion.
iii) More stable than BJT.	iii) Less stable than FET
iv) The FET is voltage controlled device or voltage amplifier.	iv) It is current controlled device or current amplifier
v) Input impedance offered much higher than BJT	v) Input impedance offered is Less
vi) Easy to fabricate and required less space and hence all the ICs use as their basic technology and preferred VLSI design.	vi) Not easy as compared to FET.
vii) Less noisy compared to BJT thats way extensively used in communication devices.	vii) Required more space than FET.
viii) Offers high power gain compared to BJT	vii) More noisy than FET.