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M-2 (H) Paper-IV

Junction Field-Effect Transistor (JFET)

Fig shows a junction field effect transistor. It consists of a uniformally doped semiconductor bar with ohmic contacts at both ends and with semiconductor junctions on both sides of the bar.

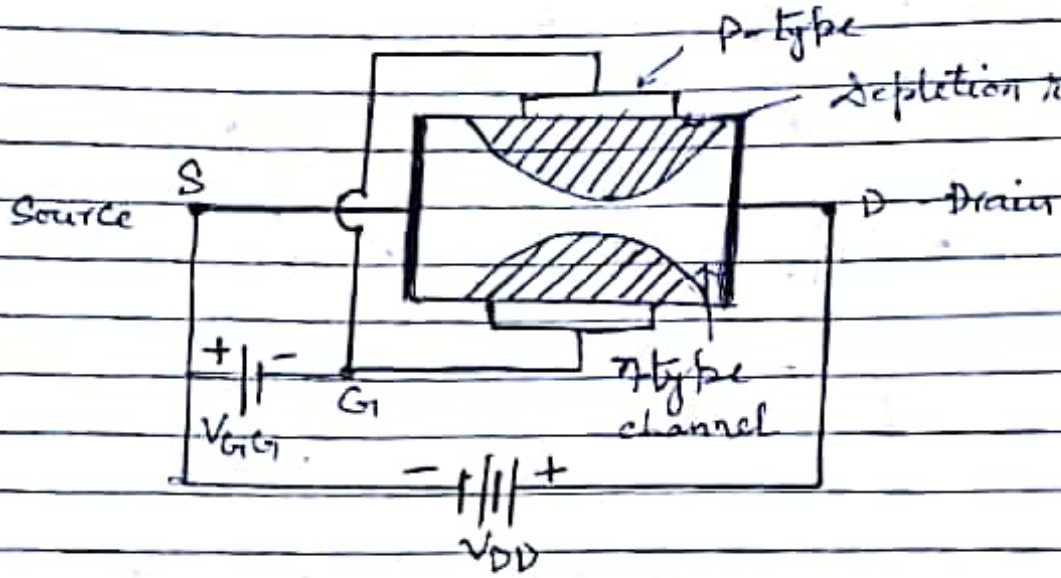


Fig. 1 A JFET

For n-type bar the FET is n-channel FET and for p-type, it is called p-channel FET. Current is allowed to flow by applying a voltage between the end terminals of the bar. The current is carried by majority carriers. The different notations in the fig are :-

S (Source) :- The terminal through which the majority carriers ~~entered~~ (enter) the channel is called the source.

D (Drain) :- The terminal through which the majority carriers leave the channel is called the drain.

G (Gate) :- On both sides of the doped semiconductor bar heavily doped regions are formed by alloying, diffusions or by other techniques using impurities opposite to that of the channel. These regions are called the gate.

The circuit symbol of n-type & p-type FET are shown in fig.

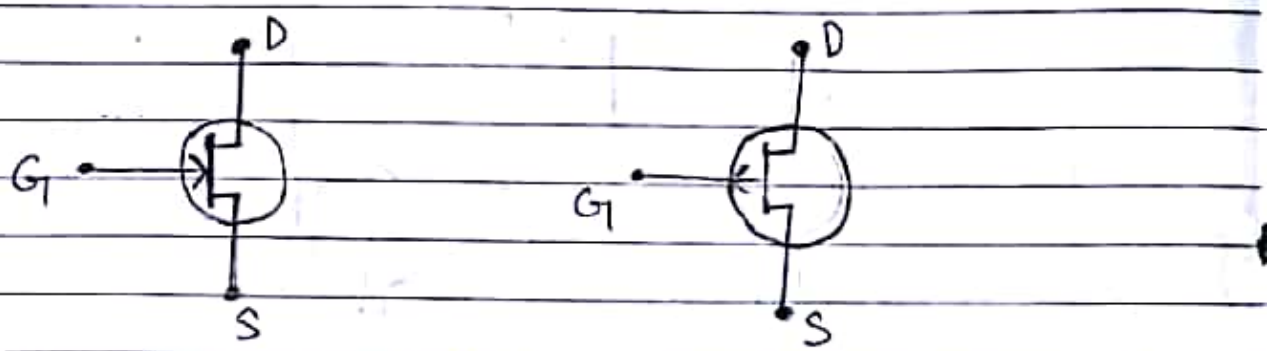
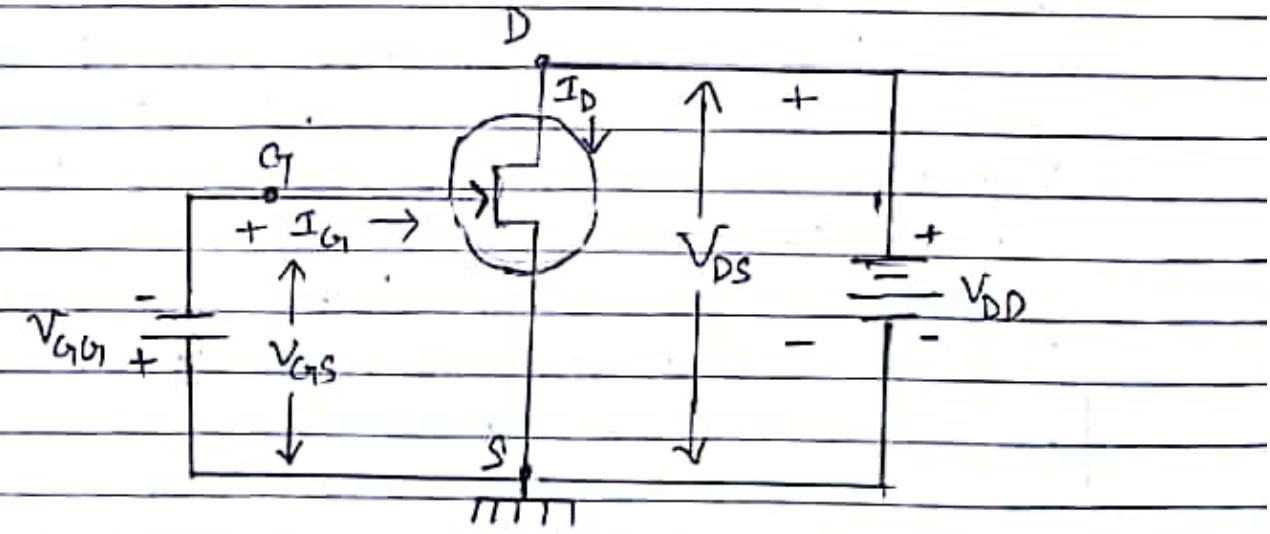


fig.2 (a) n-channel FET (b) p-channel FET

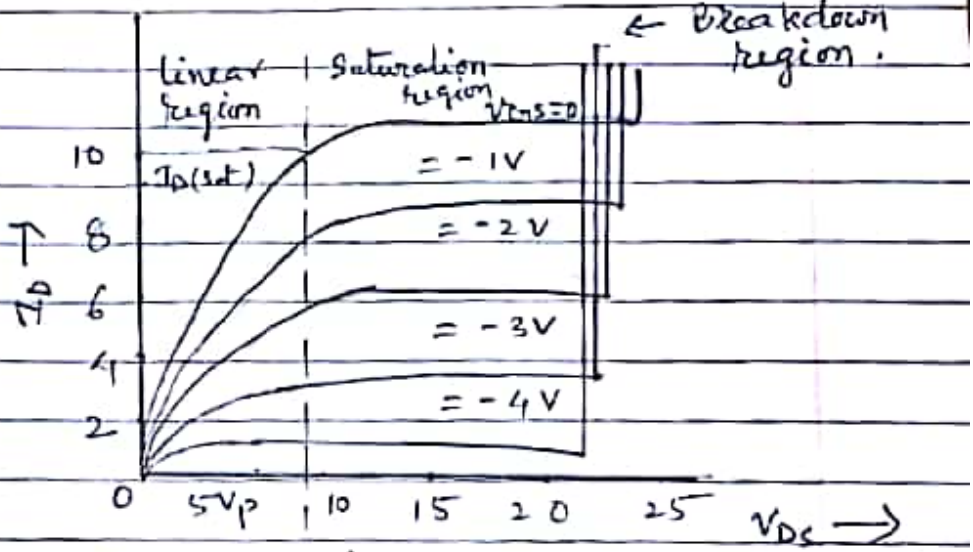
An n-channel FET with the terminal connected to voltage sources is shown in fig.1 and also schematically in fig.3. The voltage V_{GG} & V_{DD} respectively supply the gate voltage & the drain voltage.



n-channel - FET

Principle of Operation :- When the junction between the gate & the source is reverse-biased there will be depletion region on both sides of the channel. The depletion regions contain only immobile charges and no free carriers, therefore the conductivity of these regions will be practically zero. For a fixed drain to source voltage the drain current will be a fn. of the gate to source voltage.

Static characteristic :- (i) The graphical plots of I_D against V_{DS} with V_{GS} as a parameter are termed as static characteristic of the FET.



Linear region, where I_D is const. V_{DS} is small and I_D is proportional to V_{DS}.

(ii) Saturation region, where I_D is const. and is independent of V_{DS} and

(iii) Breakdown region, where I_D rises with a slight increase of the V_{DS}.

To explain these features let us consider $V_{GS}=0$. When voltage V_{DS} is increased from 0 to a small amount the n-channel bar acts as a simple resistor, hence I_D increases linearly with V_{DS} in this region. With increasing V_{DS}, the characteristic bends, and finally at a value Vp o

the voltage V_{DS} the current I_D saturates at a value $(I_D)_{sat}$.

The channel is now said to be pinched off, and the voltage V_P is called pinched off voltage. Breakdown occurs at a lower value of V_{DS} when the magnitude of the reverse bias voltage V_{GS} is increased.

Transfer characteristic :- It gives the variation of $(I_D)_{sat}$ with V_{GS}.