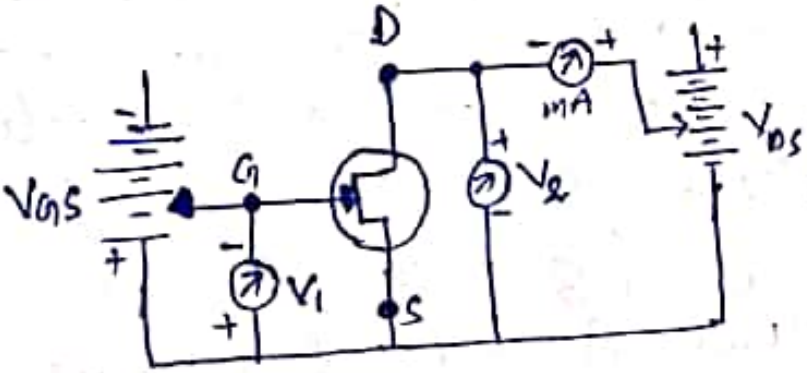
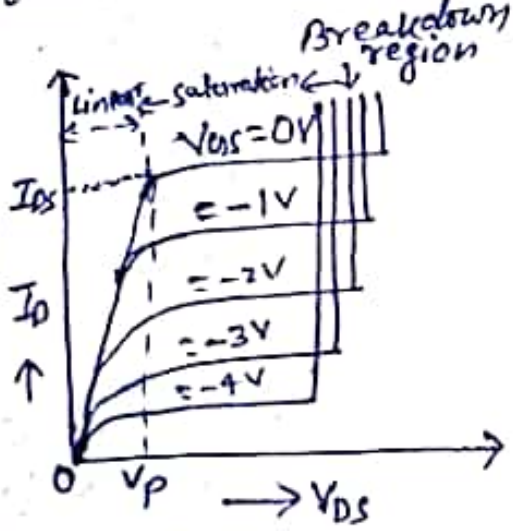
Static characteristics OF FET

The graphical plot of the drain current (I_D) against the drain-to-source voltage V_{DS} with the gate-to-source voltage V_{GS} as a parameter are termed the static or the common-source drain characteristics of a junction FET. A typical set of characteristic for an n-channel FET is shown in fig(4). An experimental arrangement for obtaing the characteristics is shown in fig(5). The voltages V_{GS} and V_{DS} are recorded by the voltmeter V_1 and V_2 respectively, and the current I_D is recorded by the milliammeter mA.



Fig(5)



Fig(4)

The drain characteristics can be devided into three regions

(i) Ohmic or linear region, where the voltage V_{DS} is small and the drain current is approximately proportional to V_{DS}

(ii) Saturation region where the drain current is almost constant and is independent of V_{DS}.

(iii) Breakdown region, where the drain current rises almost vertically with a slight increase of the drain-to-source voltage.

Explaination

To explain these features of the characteristic, consider the curve for $V_{GS}=0$. When the voltage V_{DS} is increased from zero to a small amount the n-channel bar acts as a simple resistor. hence the current I_D increases linearly with V_{DS} in this region.

~~Further~~, when V_{DS} is further increased, the ohmic voltage drop along the length of the bar reverse biases the gate-source junction. This in turn, decreases the effective conducting channel cross-section. Therefore, with increasing V_{DS}, the characteristics bends, and finally at a value V_p of 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 pinch-off voltage. The pinch-off voltage V_p for an n-channel FET is given by

$$|V_p| = \frac{eN_D}{2\epsilon} a^2$$

where e = magnitude of electronic charge

N_D = the donor concentration in the channel
a = half the channel width
ϵ = the permittivity of the channel material

The excess voltage above V_p is absorbed by the depletion region thereby increasing the depletion area. The value of V_p is smaller when the V_{GS} is increased.

The maximum voltage that can be applied across a pair of terminal of a FET is limited by the breakdown of the reverse-biased gate junction. It is seen from the characteristics, that breakdown occurs at a lower value of V_{DS} when the magnitude of the reverse bias voltage V_{GS} is increased.

Transfer characteristics of FET

The variation of the saturation current $(I_D)_{sat}$ with gate to source voltage V_{GS} is known as transfer characteristic of FET. this characteristic is obtained from static characteristics. It is shown in fig (6).

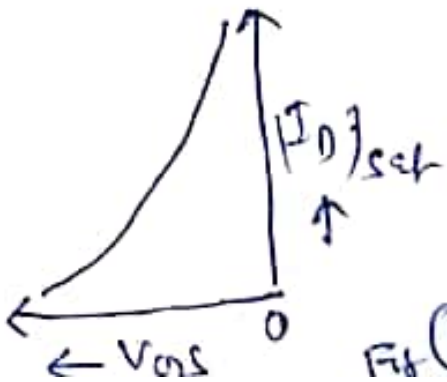


Fig (6).