
ELECTRONICS DEVICES AND CIRCUITS

OBJECTIVE

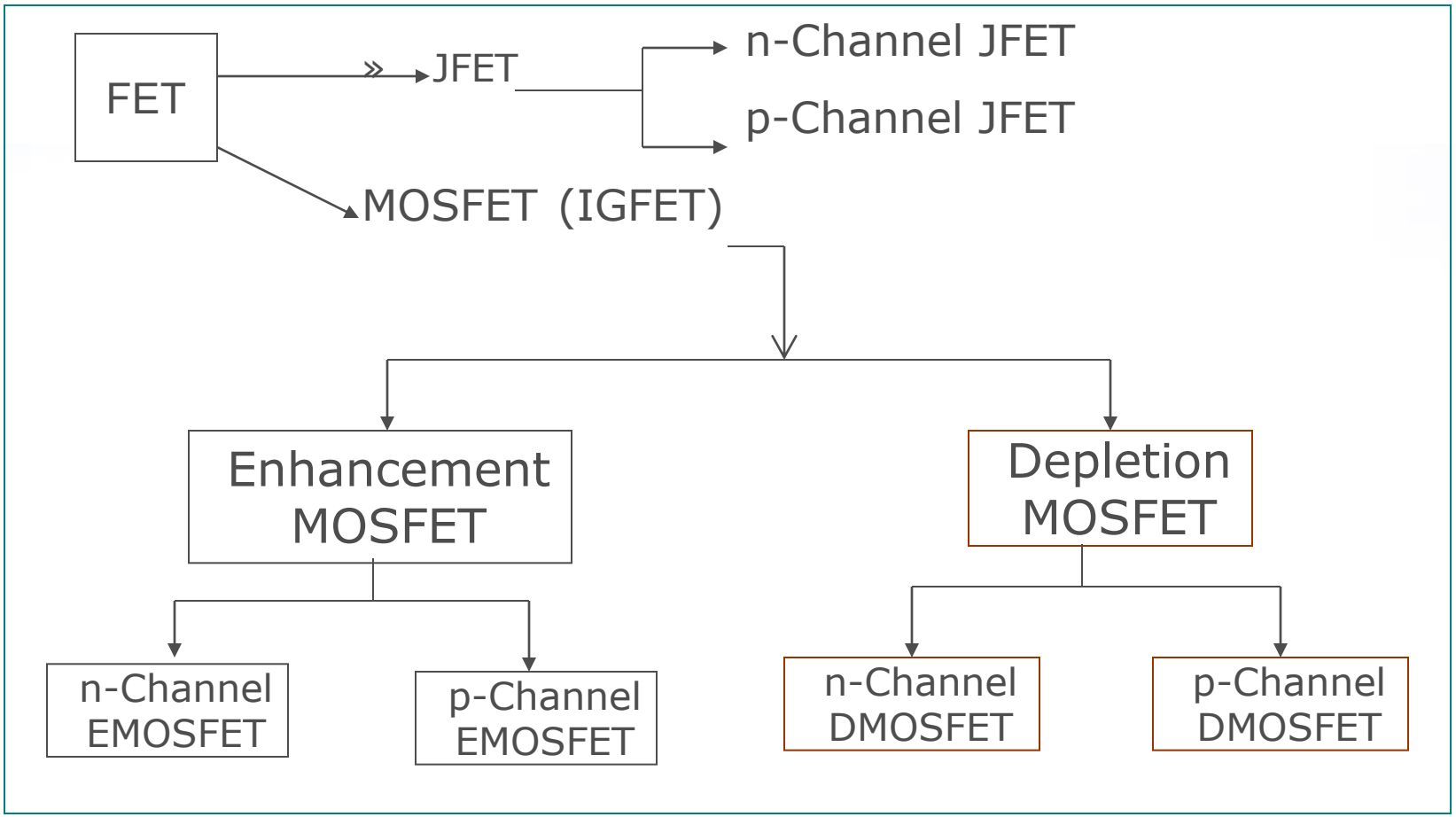
JFET

FET (Field Effect Transistor)

Few important advantages of FET over conventional Transistors

1. Unipolar device i. e. operation depends on only one type of charge carriers (*h* or *e)*
2. Voltage controlled Device (gate voltage controls drain current)
3. Very high input impedance ($\approx 10^9$-$10^{12}\ \Omega$)
4. Source and drain are interchangeable in most Low-frequency applications
5. Low Voltage Low Current Operation is possible (Low-power consumption)
6. Less Noisy as Compared to BJT
7. No minority carrier storage (Turn off is faster)
8. Self limiting device
9. Very small in size, occupies very small space in ICs
10. Low voltage low current operation is possible in MOSFETS
11. Zero temperature drift of out put is possiblek

Types of Field Effect Transistors (The Classification)



Biasing the JFET

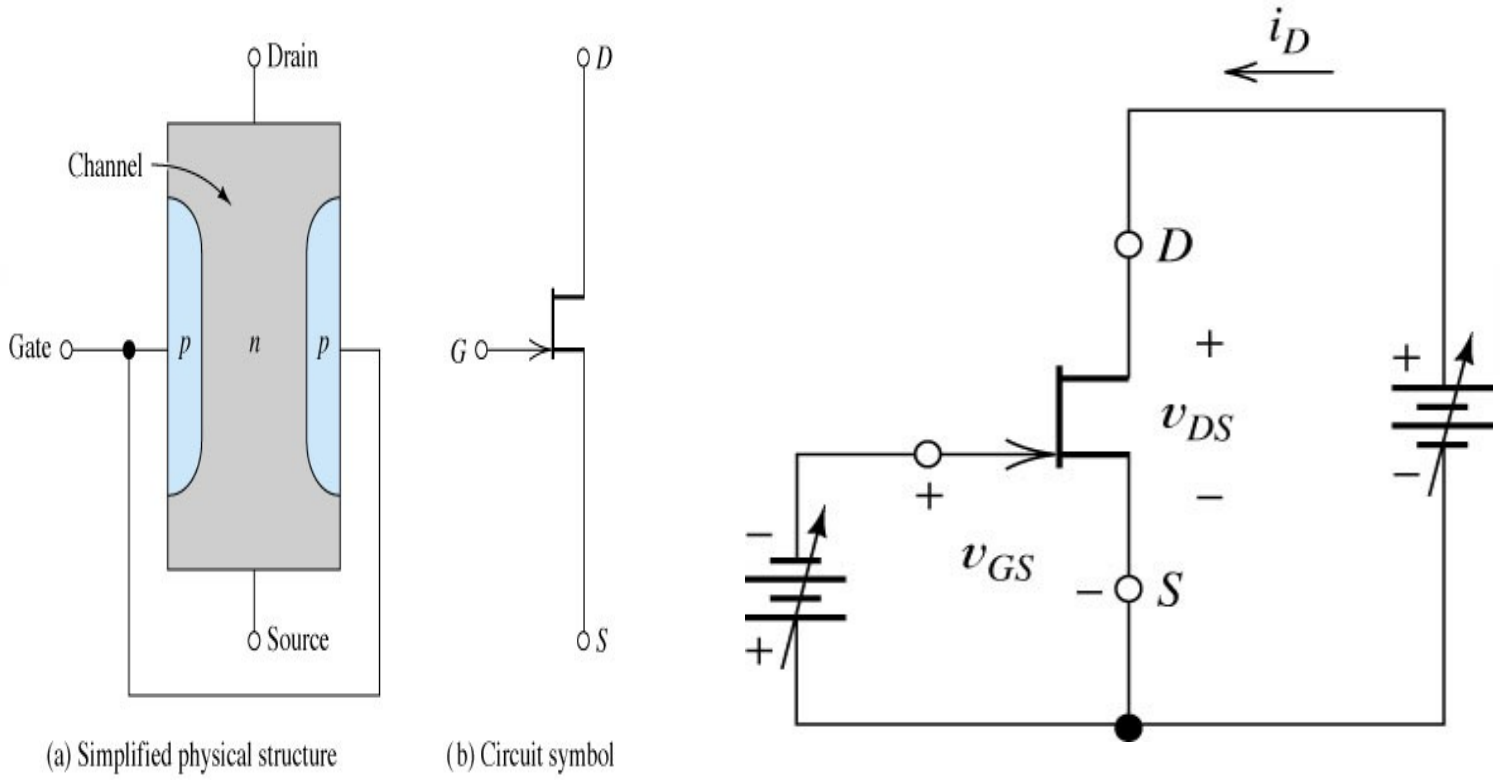
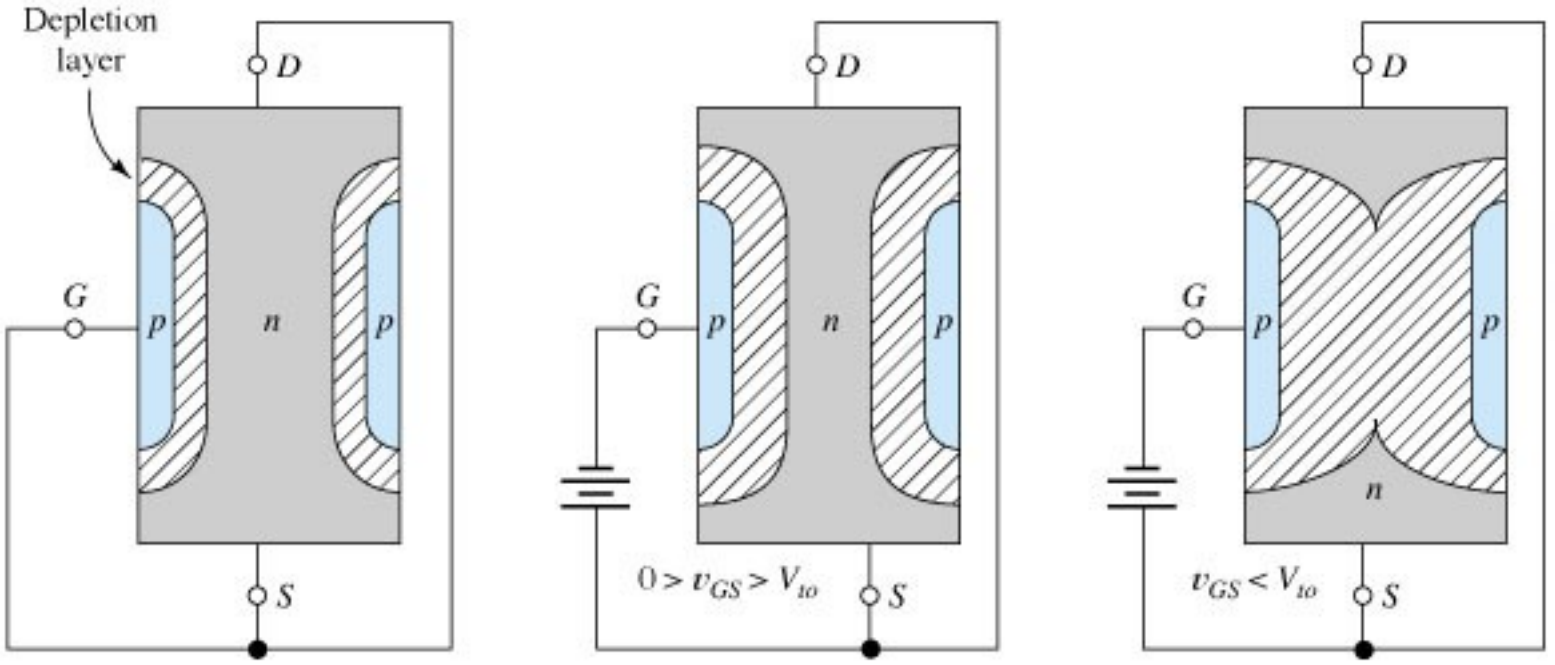


Figure: *n*-Channel JFET and Biasing Circuit.

Operation of JFET at Various Gate Bias Potentials



(a) Bias is zero and depletion layer is thin; low-resistance channel exists between the drain and the source

(b) Moderate gate-to-channel reverse bias results in narrower channel

(c) Bias greater than pinch-off voltage; no conductive path from drain to source

Figure: The nonconductive depletion region becomes broader with increased reverse bias. (*Note:* The two gate regions of each FET are connected to each other.)

Output or Drain (V_D-I_D) Characteristics of n-JFET

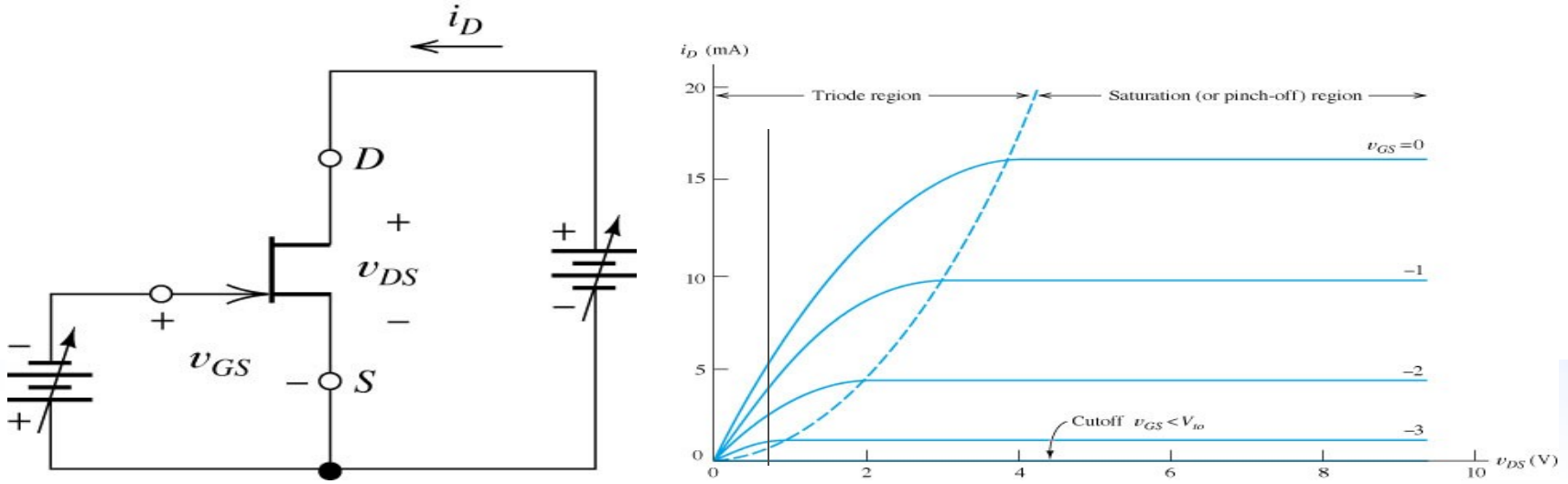


Figure: Circuit for drain characteristics of the *n*-channel JFET and its Drain characteristics.

Non-saturation (Ohmic) Region: $V_{DS} < \left(V_{GS} - V_P\right)$

The drain current is given by $I_{DS} = \frac{2I_{DSS}}{V_P^2}\left[\left(V_{GS} - V_P\right)V_{DS} - \frac{V_{DS}^2}{2}\right]$

Saturation (or Pinchoff) Region: $V_{DS} \geq \left(V_{GS} - V_P\right)$

$$I_{DS} = \frac{I_{DSS}}{V_P^2}\left[\left(V_{GS} - V_P\right)^2\right] \quad \text{and} \quad I_{DS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

Where, I_{DSS} is the short circuit drain current, V_P is the pinch off voltage

Simple Operation and Break down of n-Channel JFET

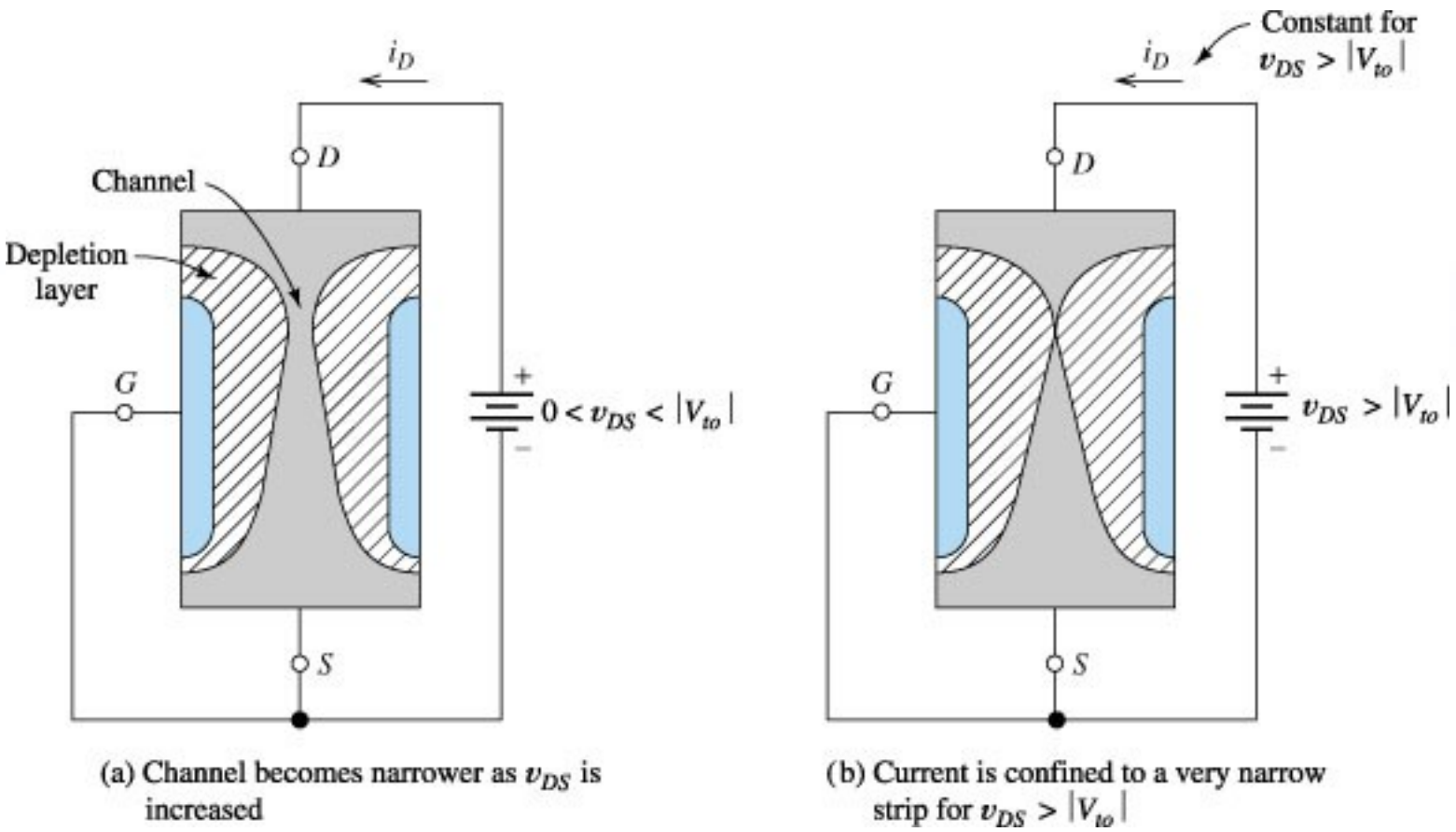


Figure: *n*-Channel FET for $v_{GS} = 0$.

N-Channel JFET Characteristics and Breakdown

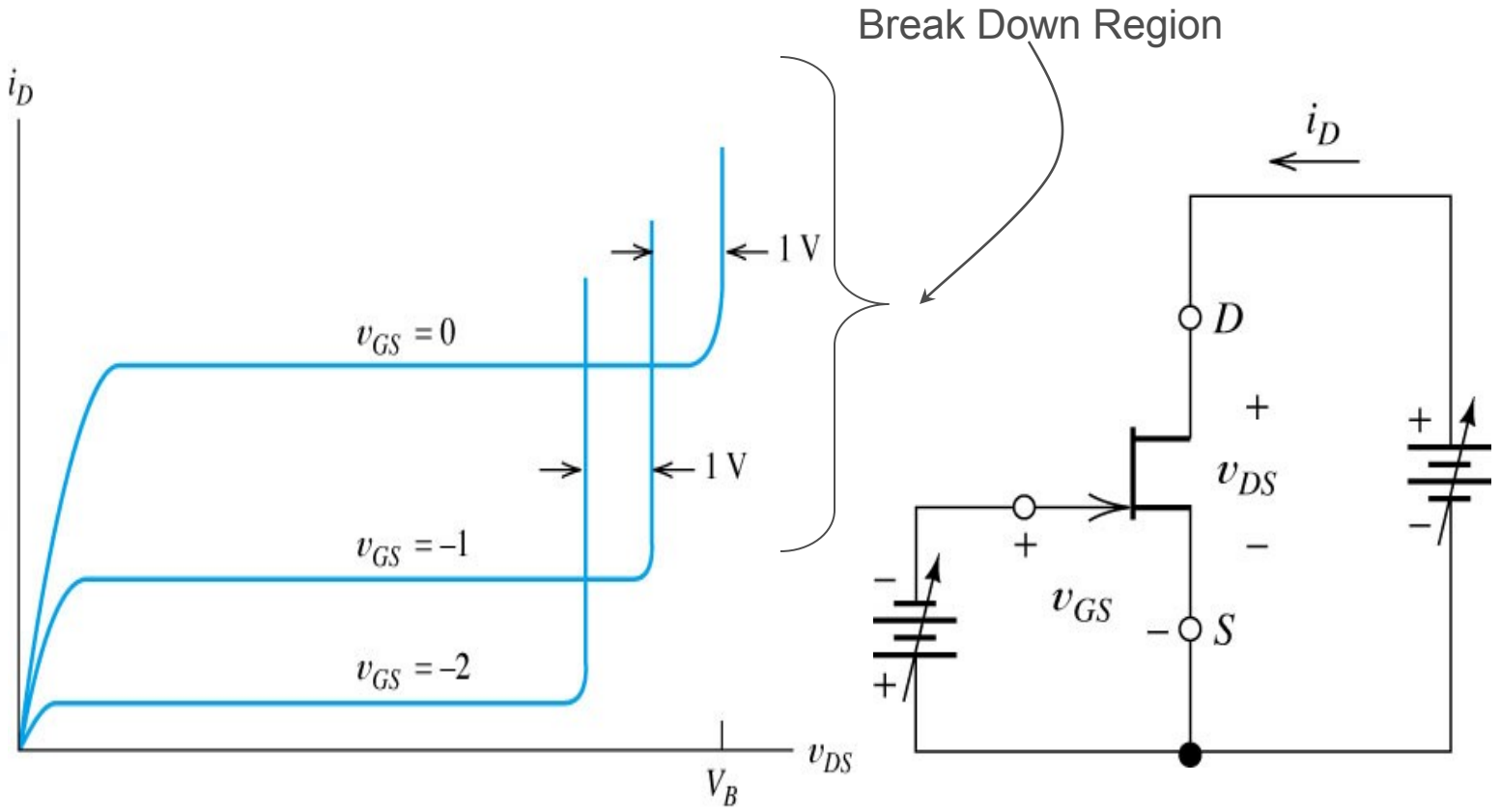


Figure: If v_{DG} exceeds the breakdown voltage V_B, drain current increases rapidly.