ELECTRONICS DEVICES AND CIRCUITS

SECTION - C

TRANSISTORS

OBJECTIVE

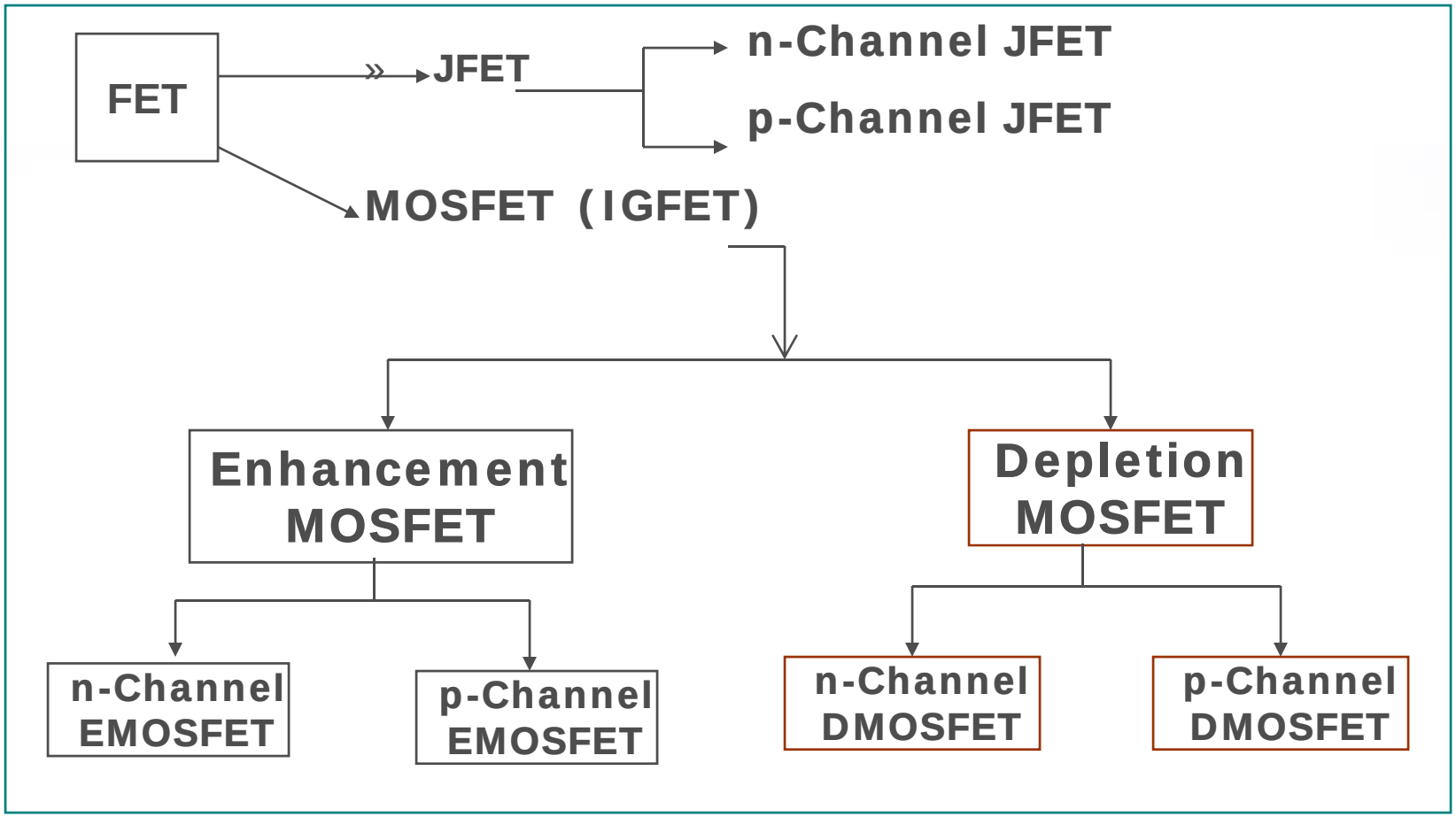
JFET

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

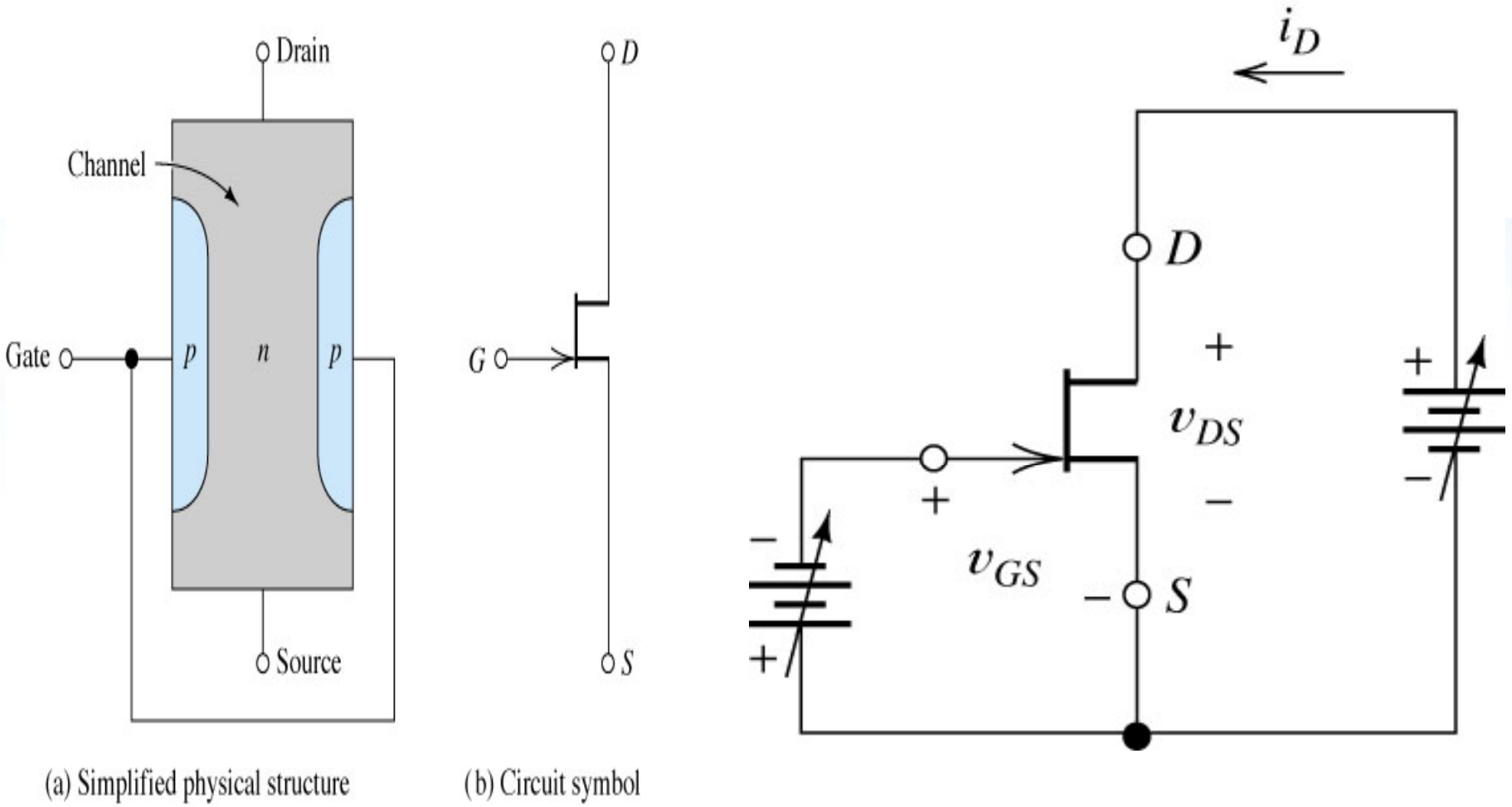
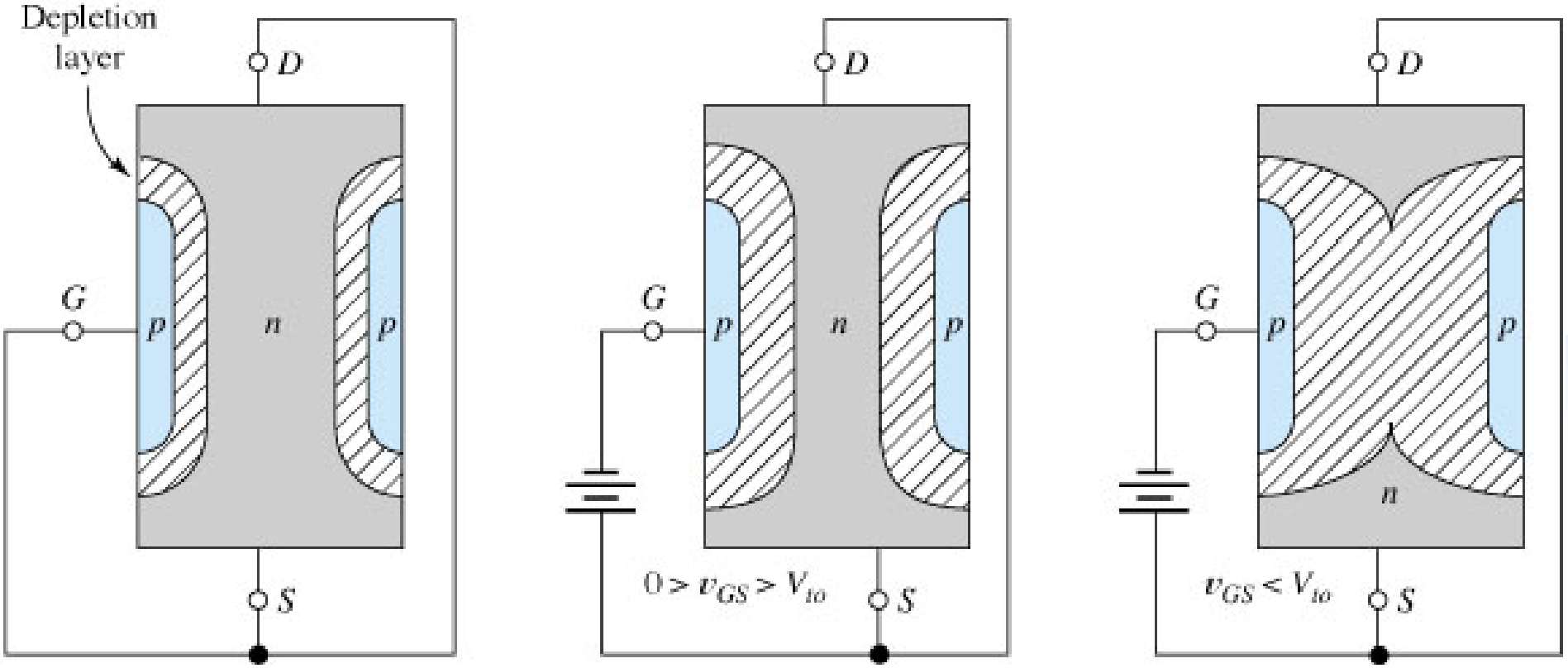


Figure: *n*-Channel JFET and Biasing Circuit.

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

Fig: 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

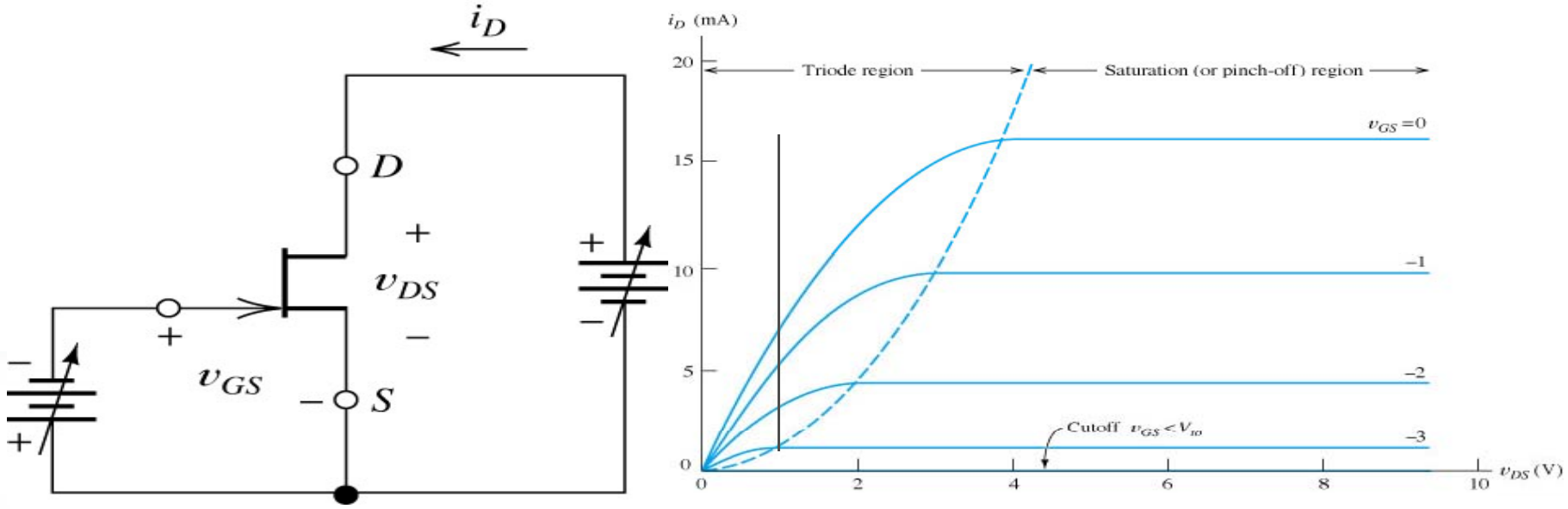


Figure: Circuit for drain characteristics of the *n*-channel JFET and its Drain characteristics.

Non-saturation (Ohmic) Region: →

$$V_{DS} < \left(V_{GS} - V_P \right)$$

The drain current is given by

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

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

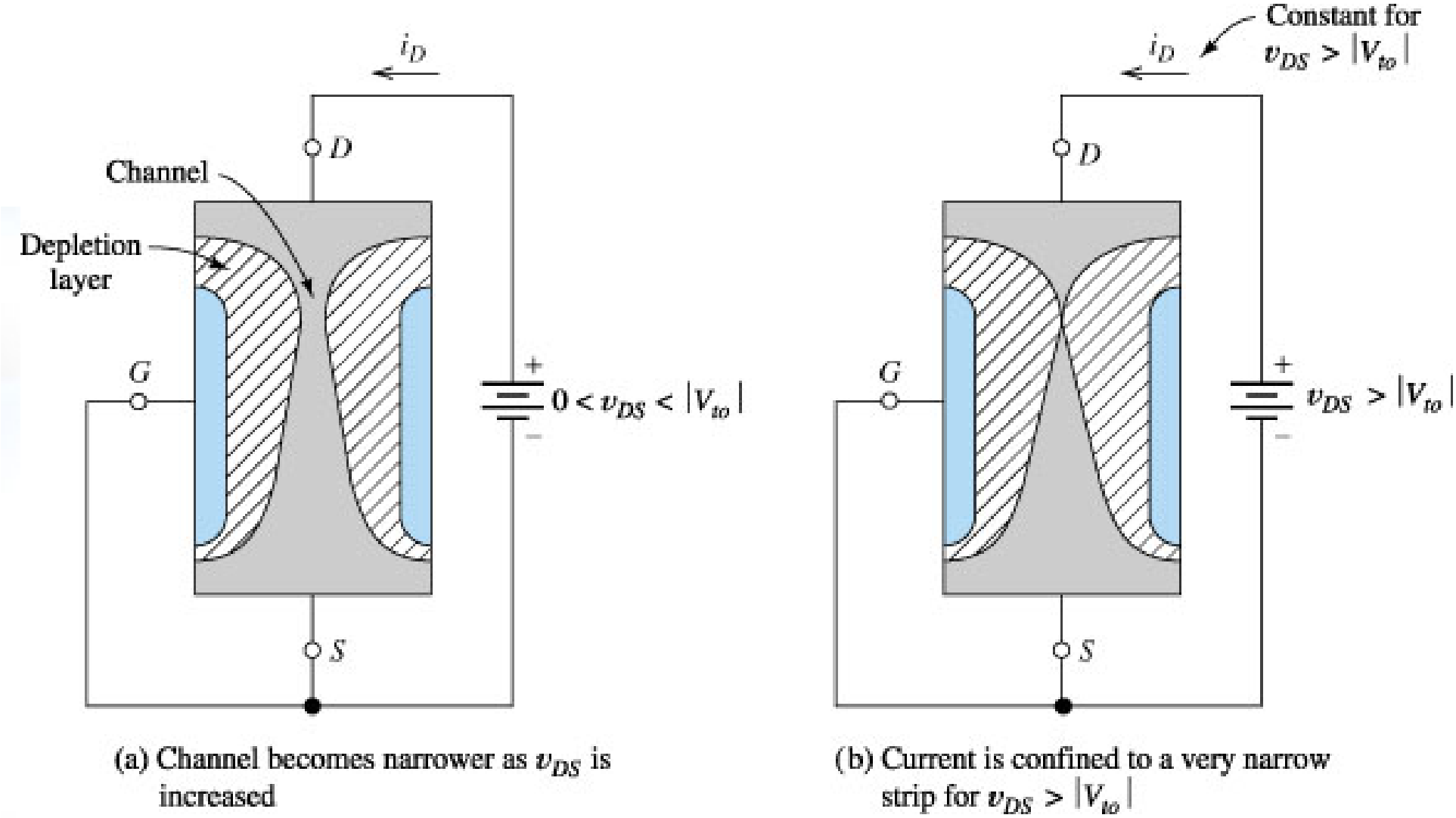


Figure: *n*-Channel FET for $v_{GS} = 0$.

N-Channel JFET Characteristics and Breakdown

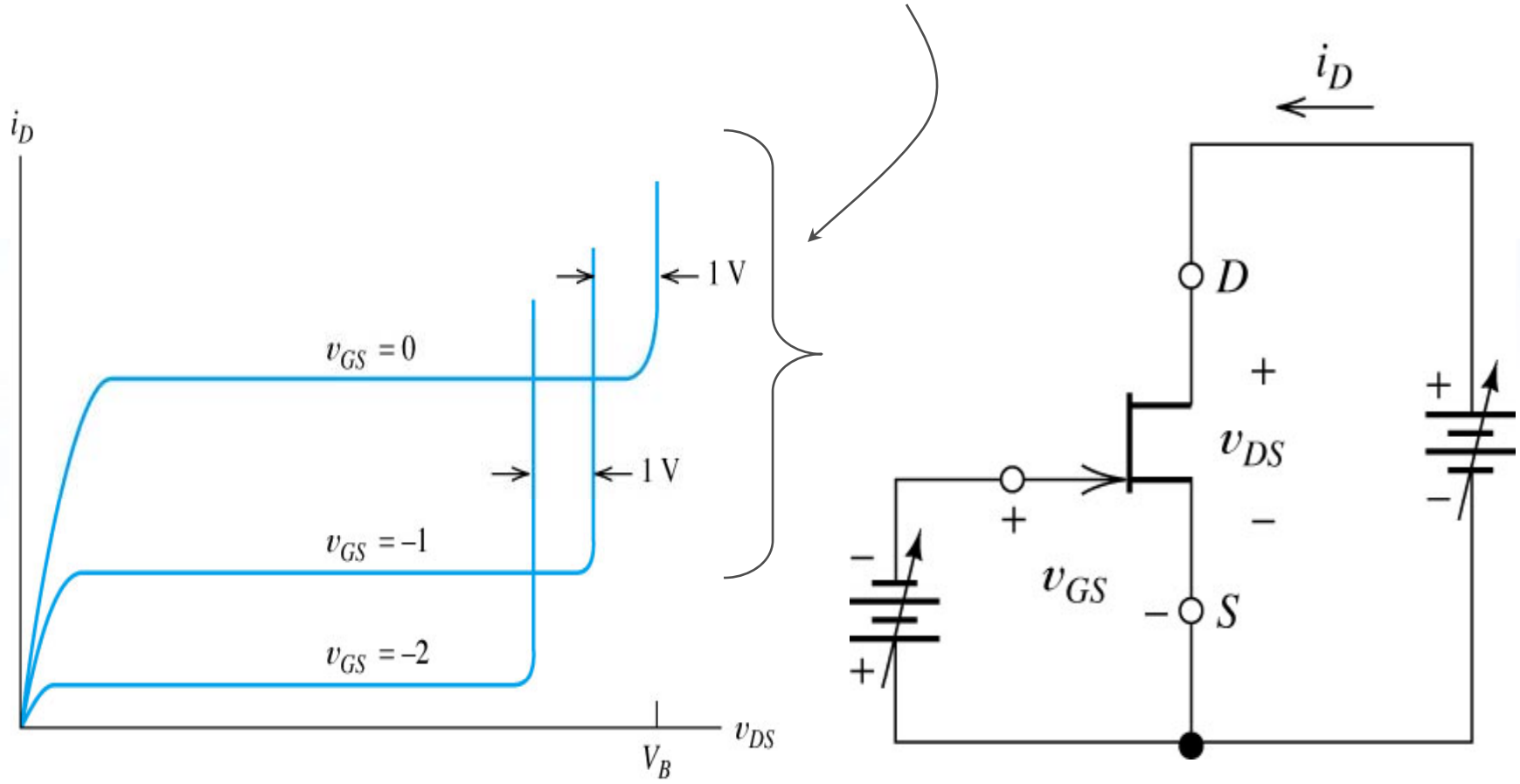


Figure: If v_{DG} exceeds the breakdown voltage V_B, drain current increases rapidly.