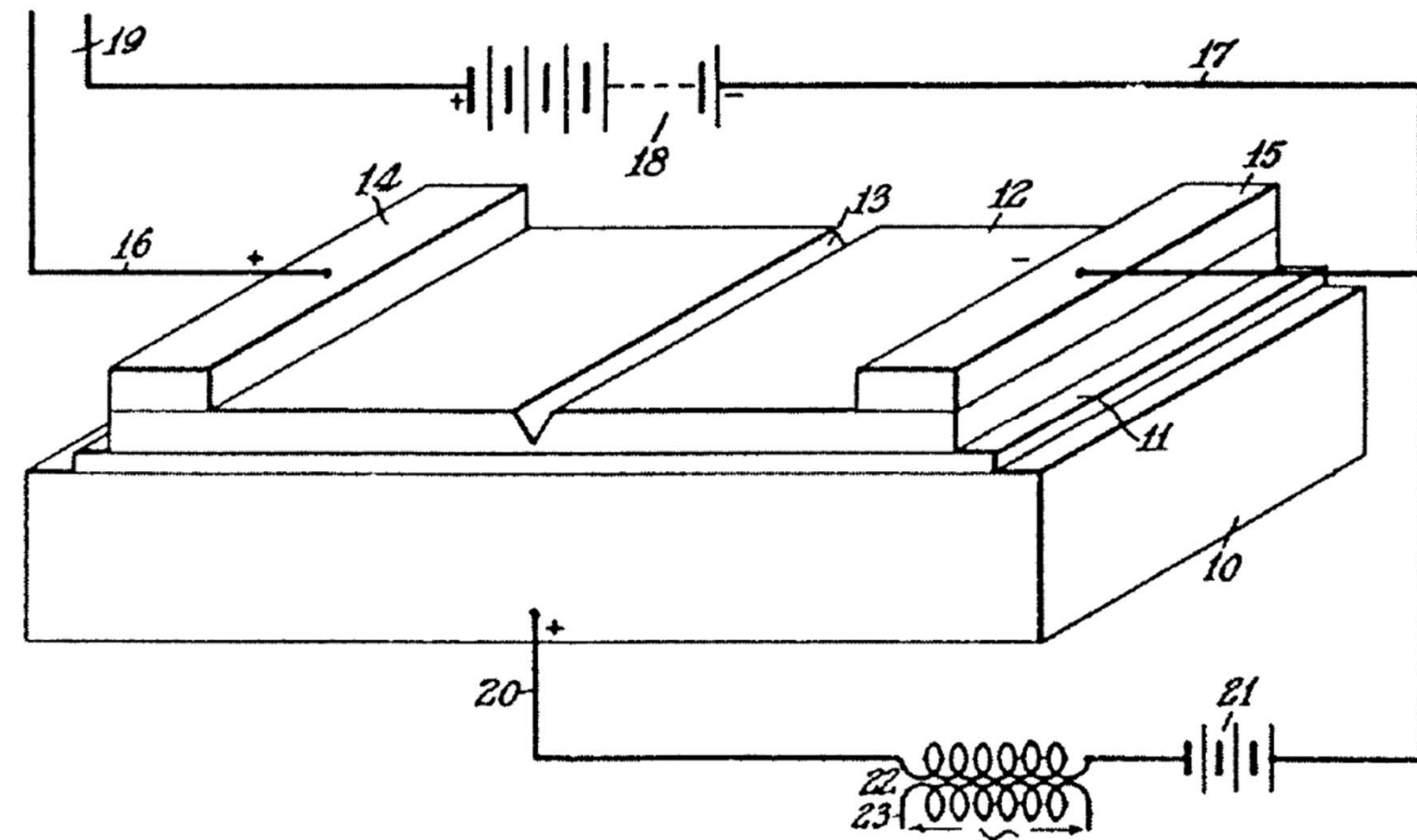


Overview of the MOS transistor

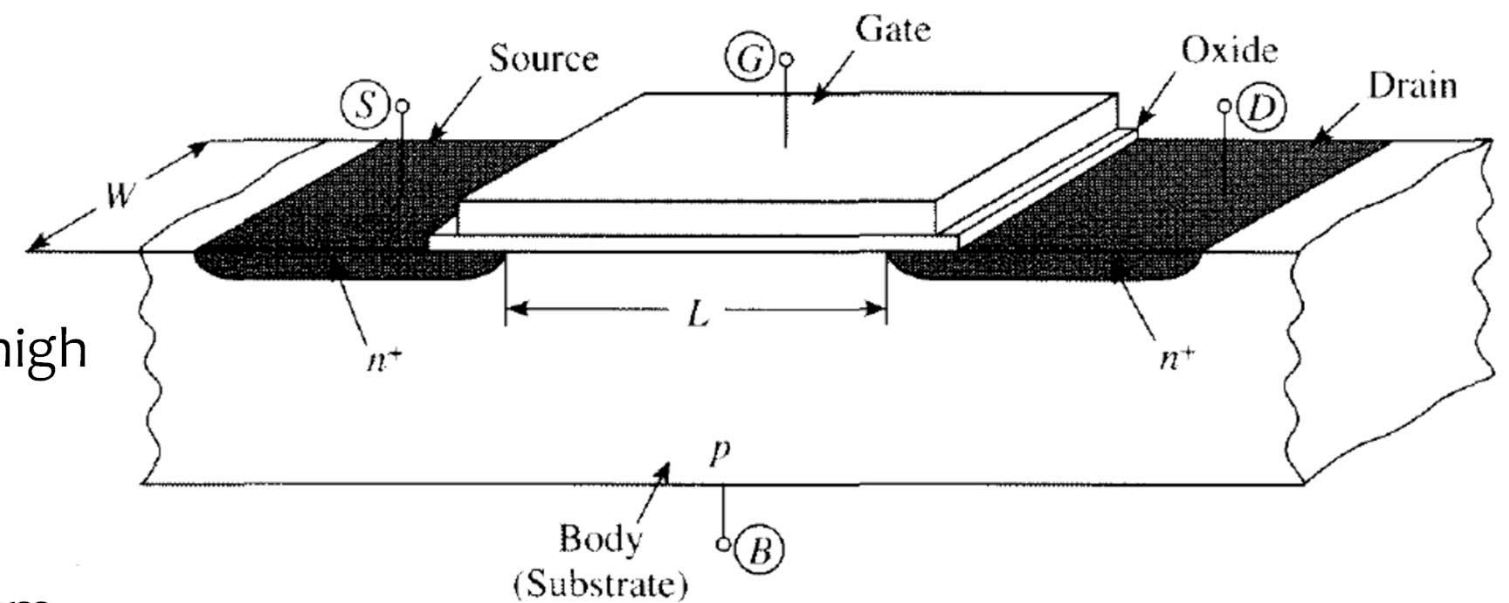
Overview of the MOS transistor

- Basic idea – 1930, . Lilienfeld
- Lab study – 1940, Heil
- Development method for growing oxide – 1960, Kahng and Atalla
-



Overview of the MOS transistor...

- Simple operation of n-MOS
- p-doped Body concentration : $10^{16} /\text{cm}^3$ to $10^{18}/\text{cm}^3$
- Body or substrate
- Oxide thickness : 1.2 nm (high performance) to 10s nm (high voltage transistor)
- Gate: heavily doped n or p type polysilicon ($10^{20}/\text{cm}^3$)
- Source and Drain: heavily doped n type dopant with 10 nm depth in modern technology
- Lateral diffusion : 10 nm in modern technology due to high temp. fabrication steps –ion movement
- Channel: $w \times L$, where L is the channel length.
- In digital application L designed so that become minimum



Overview of the MOS transistor...

- The positive gate potential effect: preparing the channel by attracting the electron to oxide semiconductor interference
- The number of electrons in the channel can be varied through the gate potential – Channel strength variation.
- Source and Drain bias
 - With same voltage bias: no current
 - with different bias voltage: one with lower voltage act like a source and inject electron to channel and the other one sinks electrons of channel
- S, G, D and B acronyms
- MOS, MOSFET, MOST (MOS Transistor), IGFET (insulated-gate field-effect transistor).
- Leakage current (1 pA): source and drain biased so that become negative in compare to body voltage. This current increases with temp. (double for each 8° C)



Overview of the MOS transistor...

■ A Qualitative Description of MOS Transistor Operation

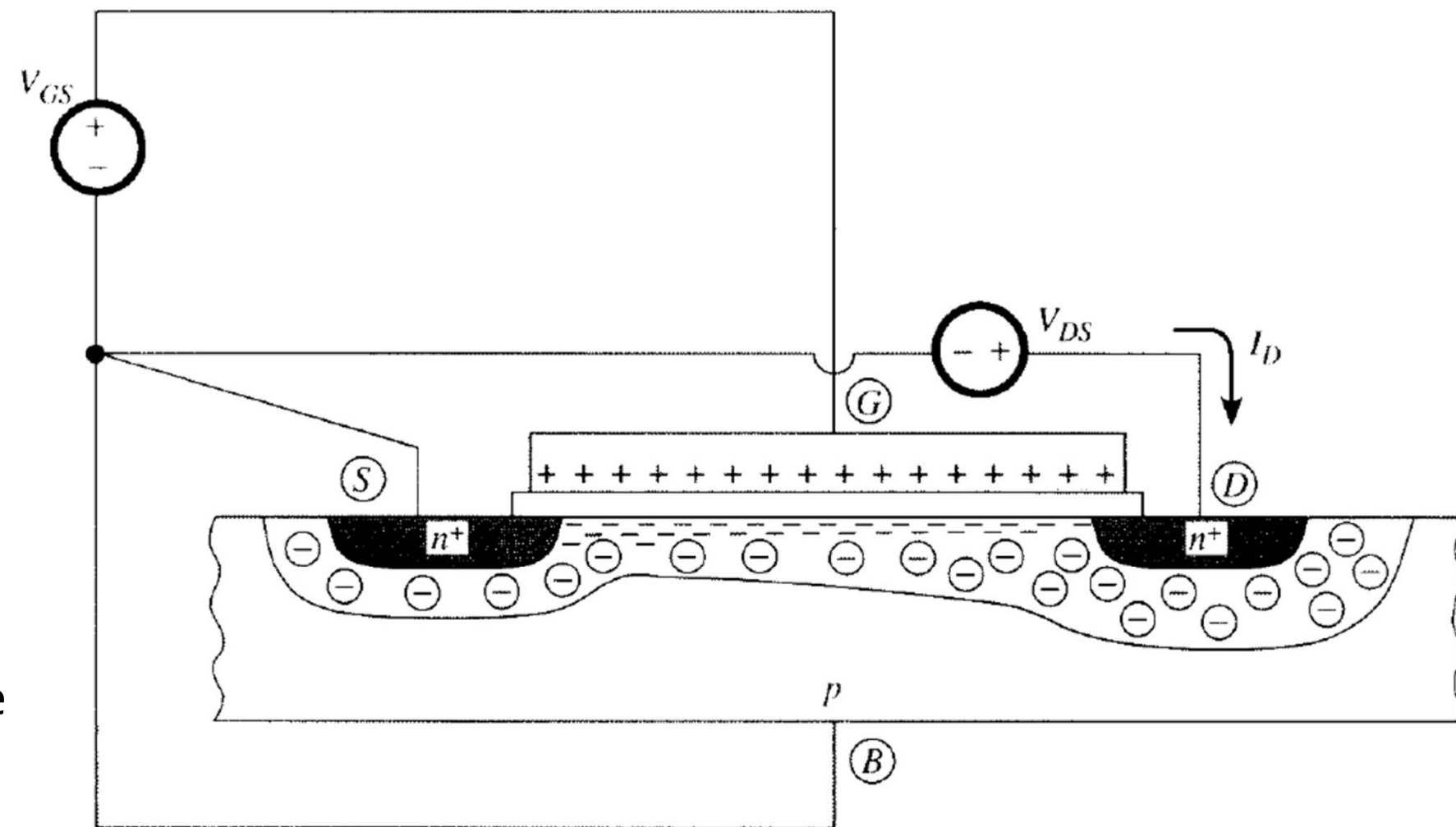
■ Channel formation – Inversion layer

- First holes repel from the surface
 - Electrons in body
 - Electrons in source and drain

■ Weak, Moderate and Strong inversion

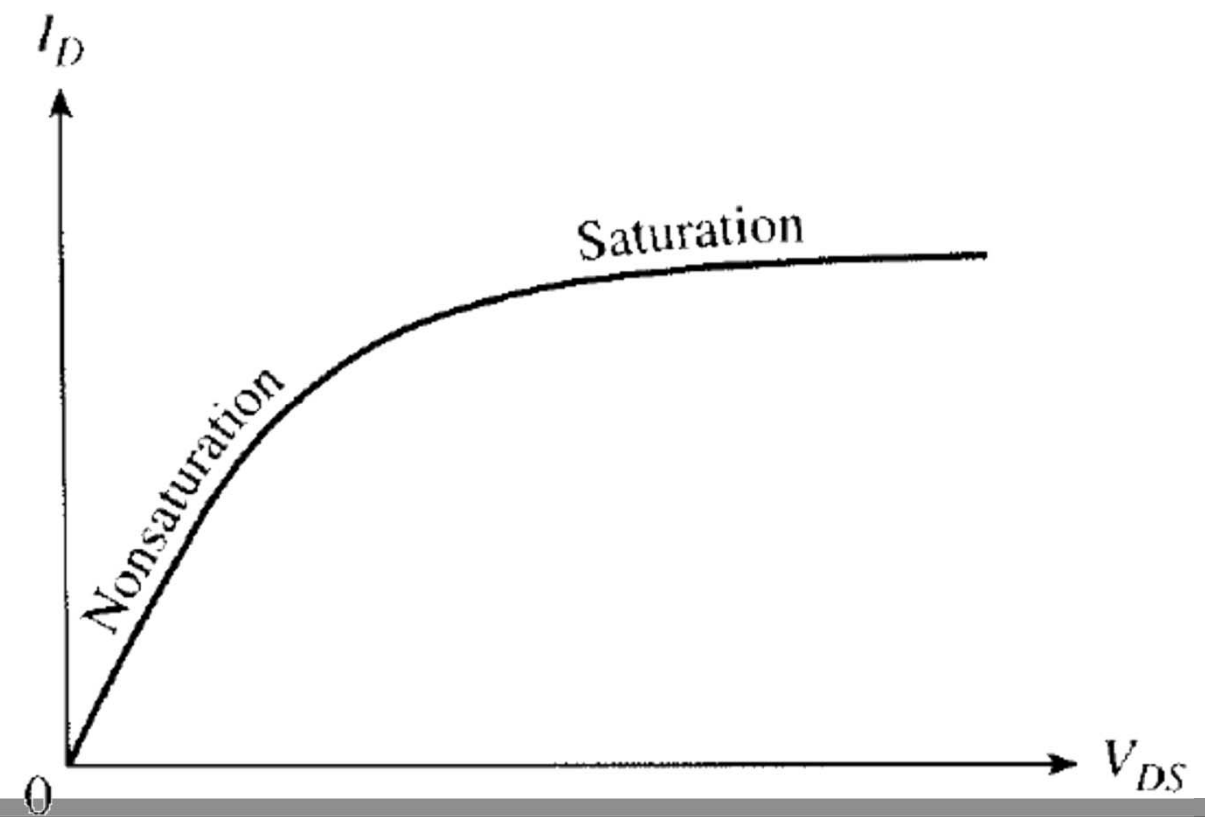
■ Source and drain to body junction:

- Form 2 np junction
- Reverse bias, why?
- $V_{DB} > V_{SB} \rightarrow$ more electrons near the source



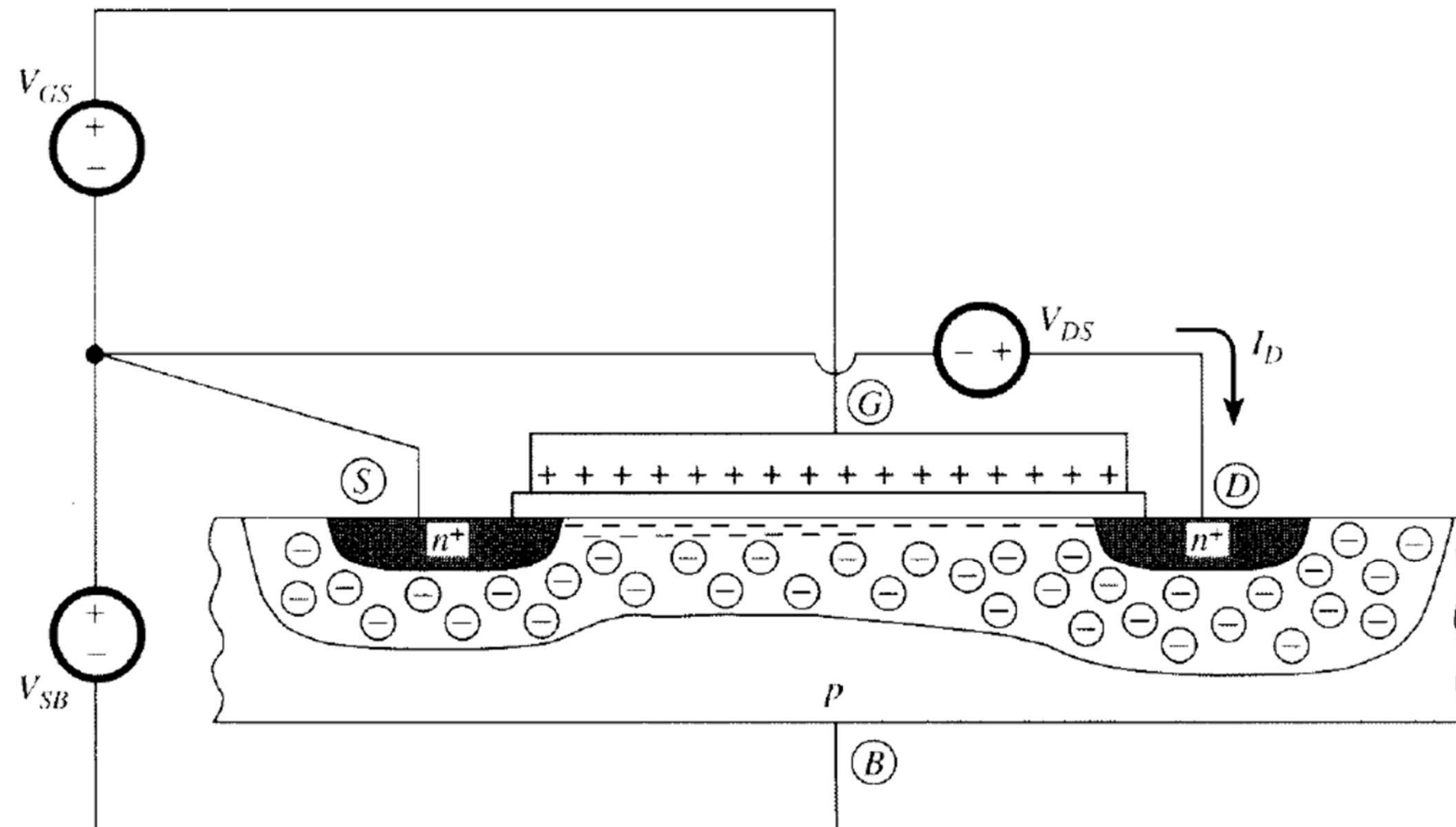
Overview of the MOS transistor...

- Drain source voltage: V_{DS}
 - Electron movement: As it is positive electrons flow from source to drain!
 - Constant current: Slow movement near source and speed up near drain
- Current and V_{DS} Dependency
 - Saturation region- Pinch off
 - Nonsaturation region or linear region - Resistor



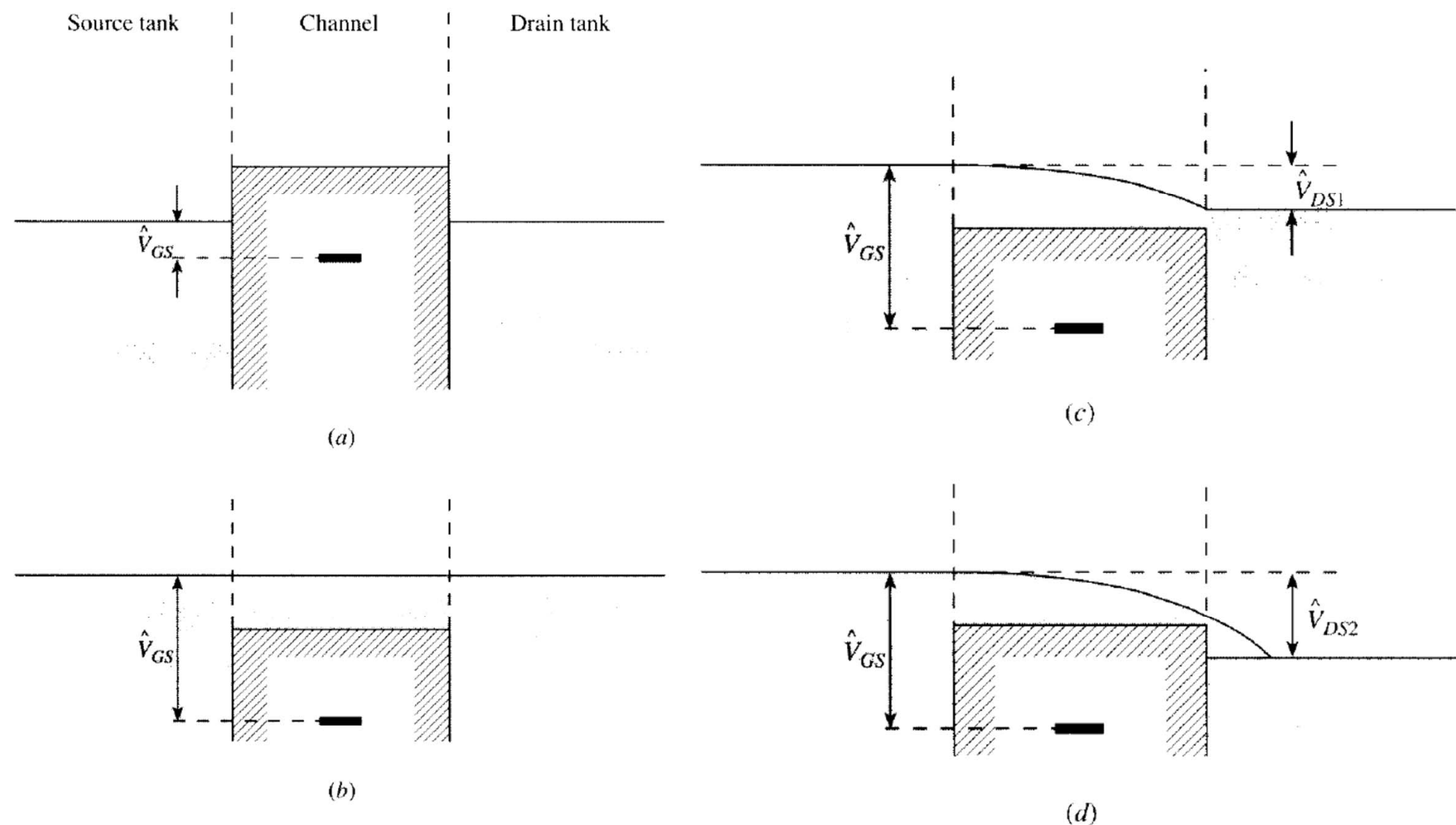
Overview of the MOS transistor...

- V_{SB} effect – Body effect
 - Decreasing the current, why?
 - Back gate concept



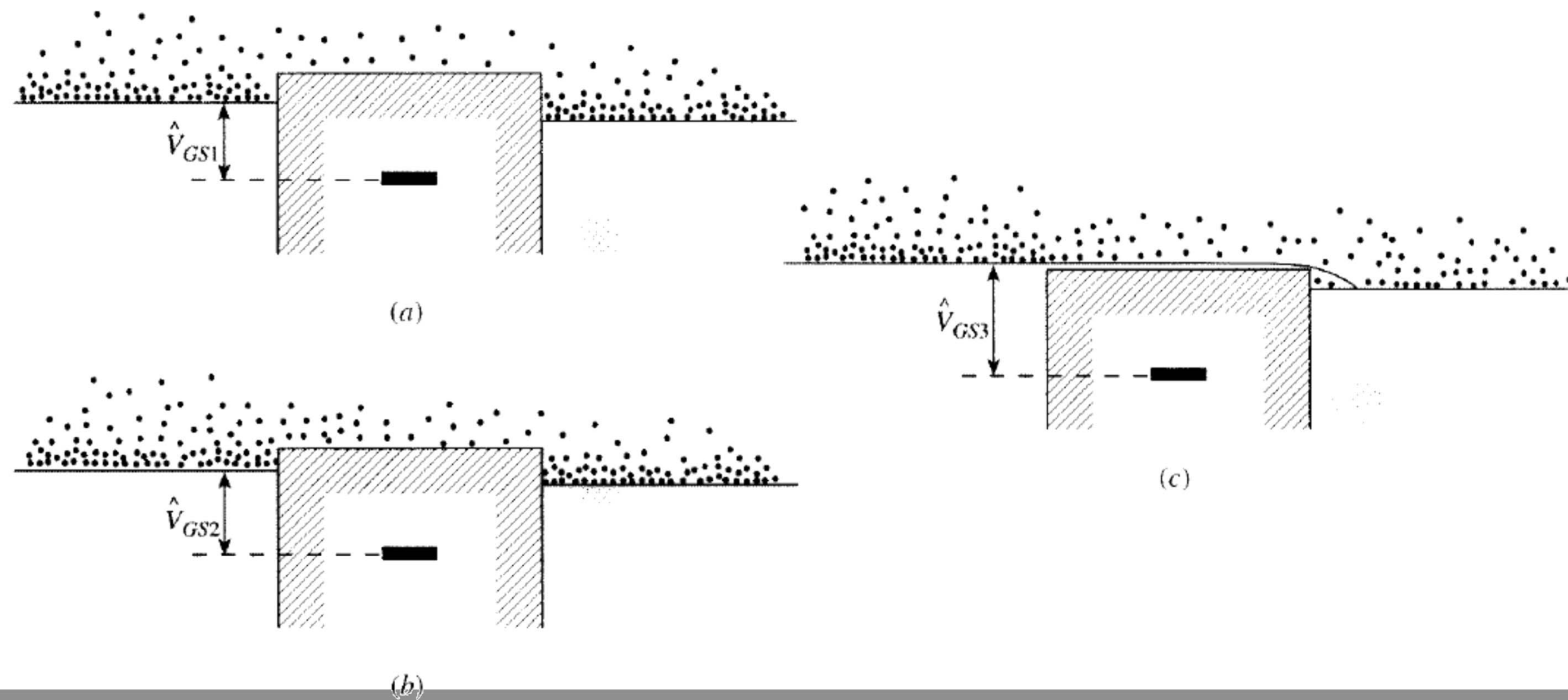
Overview of the MOS transistor...

- A Fluid Dynamical Analog



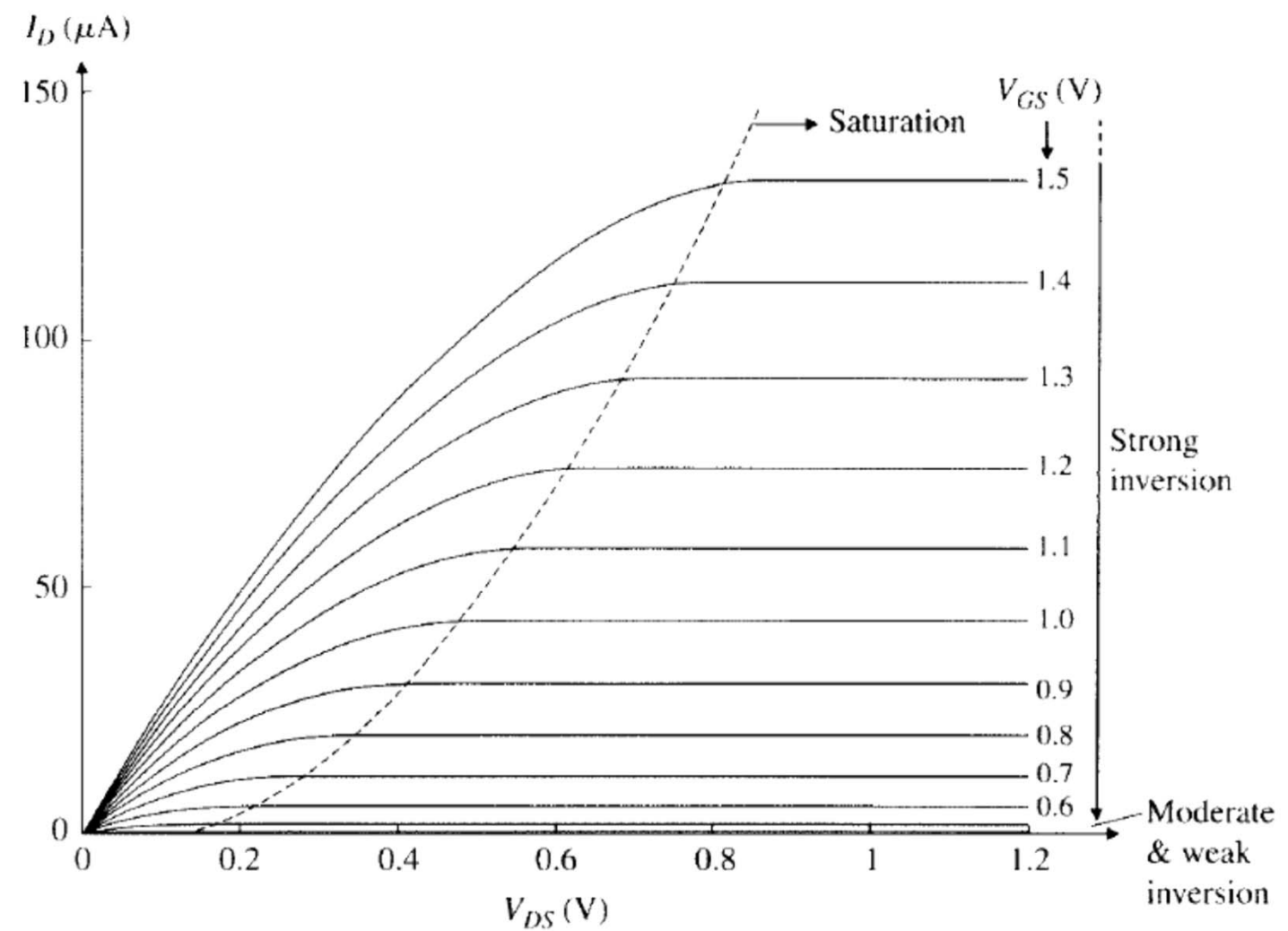
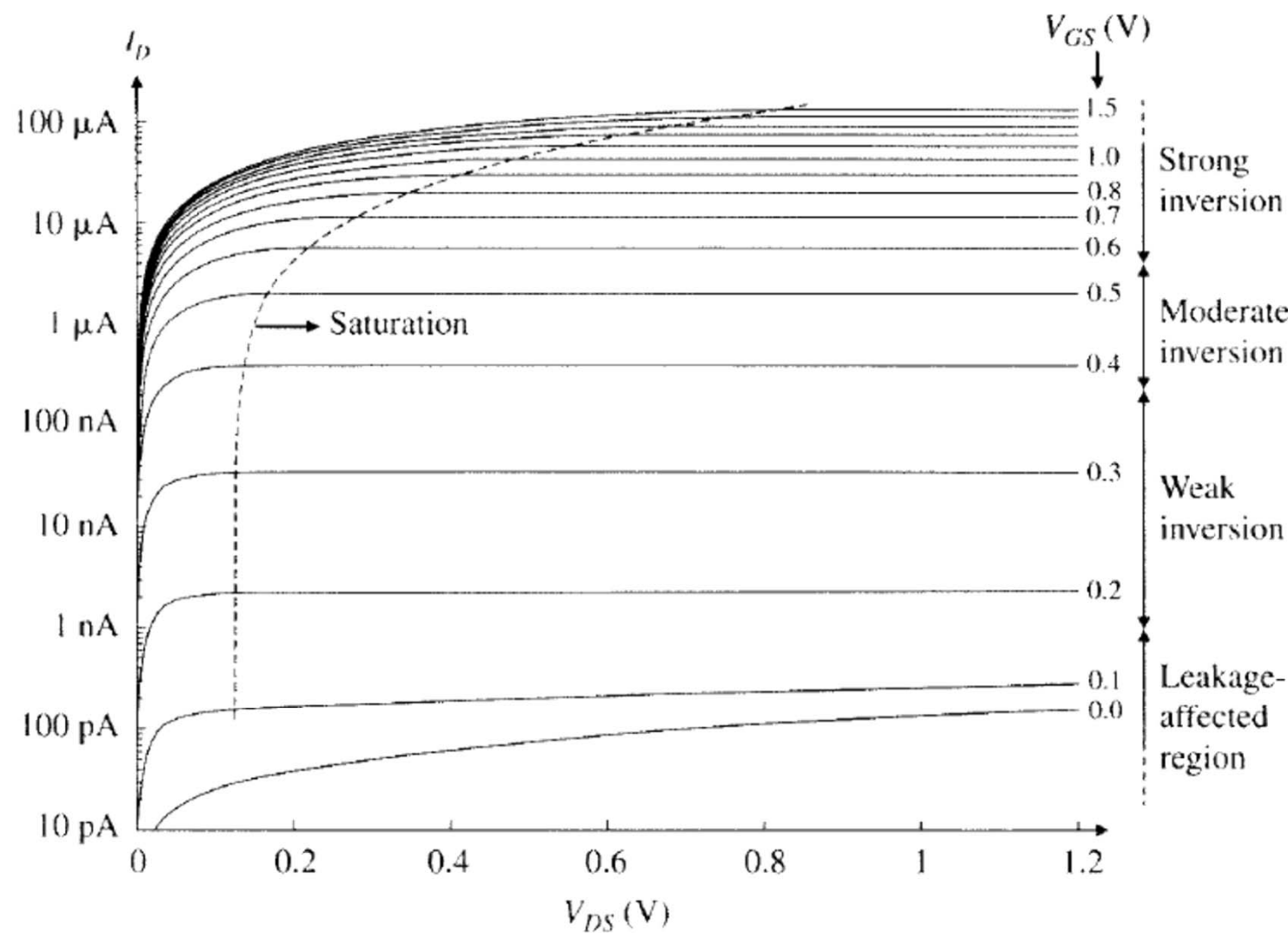
Overview of the MOS transistor...

- Carrier distribution in Weak and Moderate regime



Overview of the MOS transistor...

- MOS Transistor Characteristics – Typical value for long channel MOS



Overview of the MOS transistor...

- Operation region
 - Weak inversion
 - Diffusion mechanism is permanent
 - I_D is exponentially related to V_{GS} —Like BJT
 - Moderate inversion
 - Drift and Diffusion mechanism present
 - Strong inversion
 - Drift mechanism is permanent
 - I_D has quadratic relation to V_{GS}

