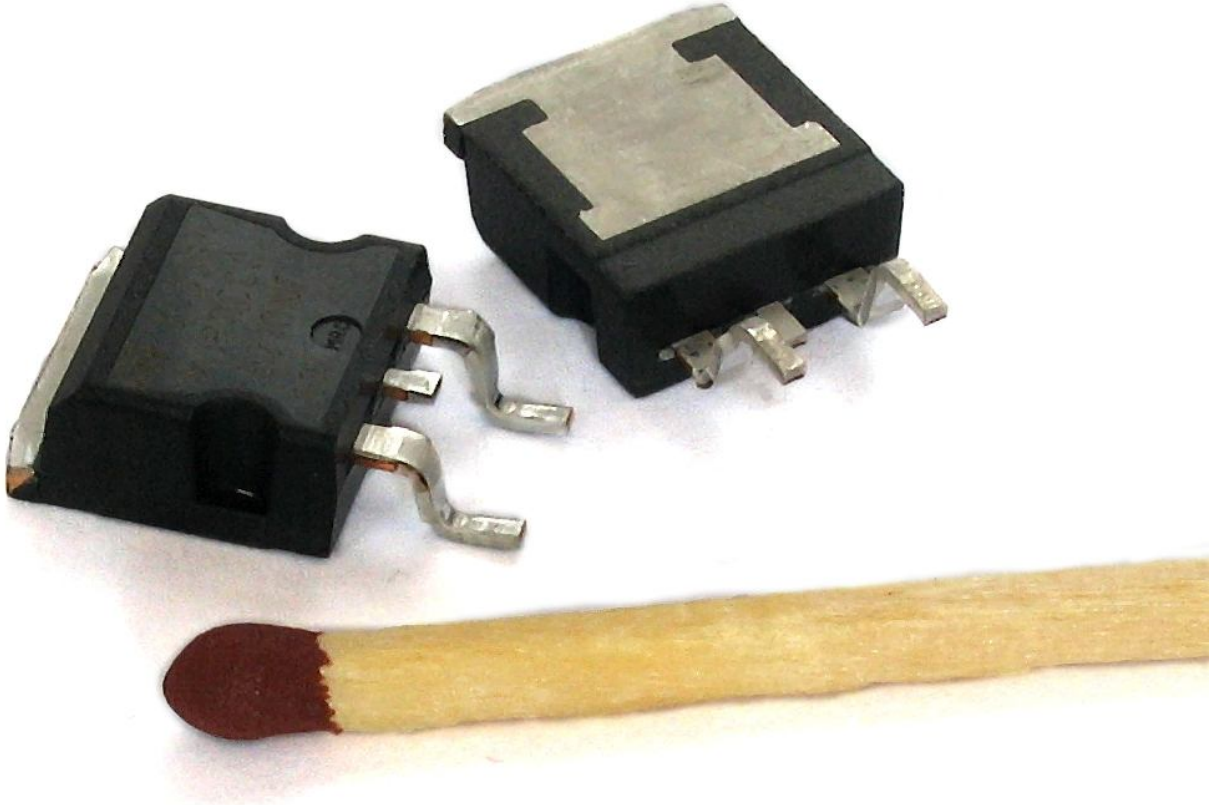
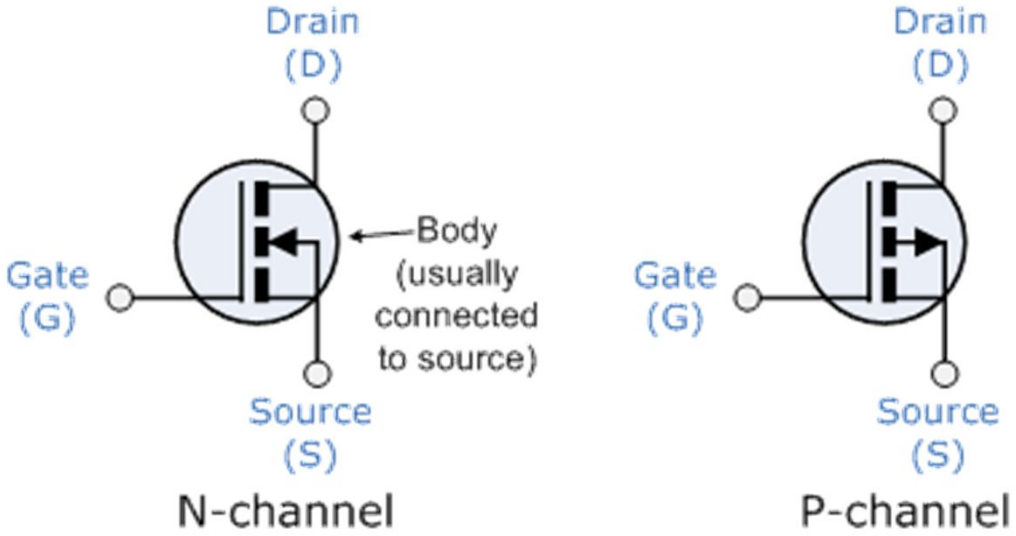
MOSFET

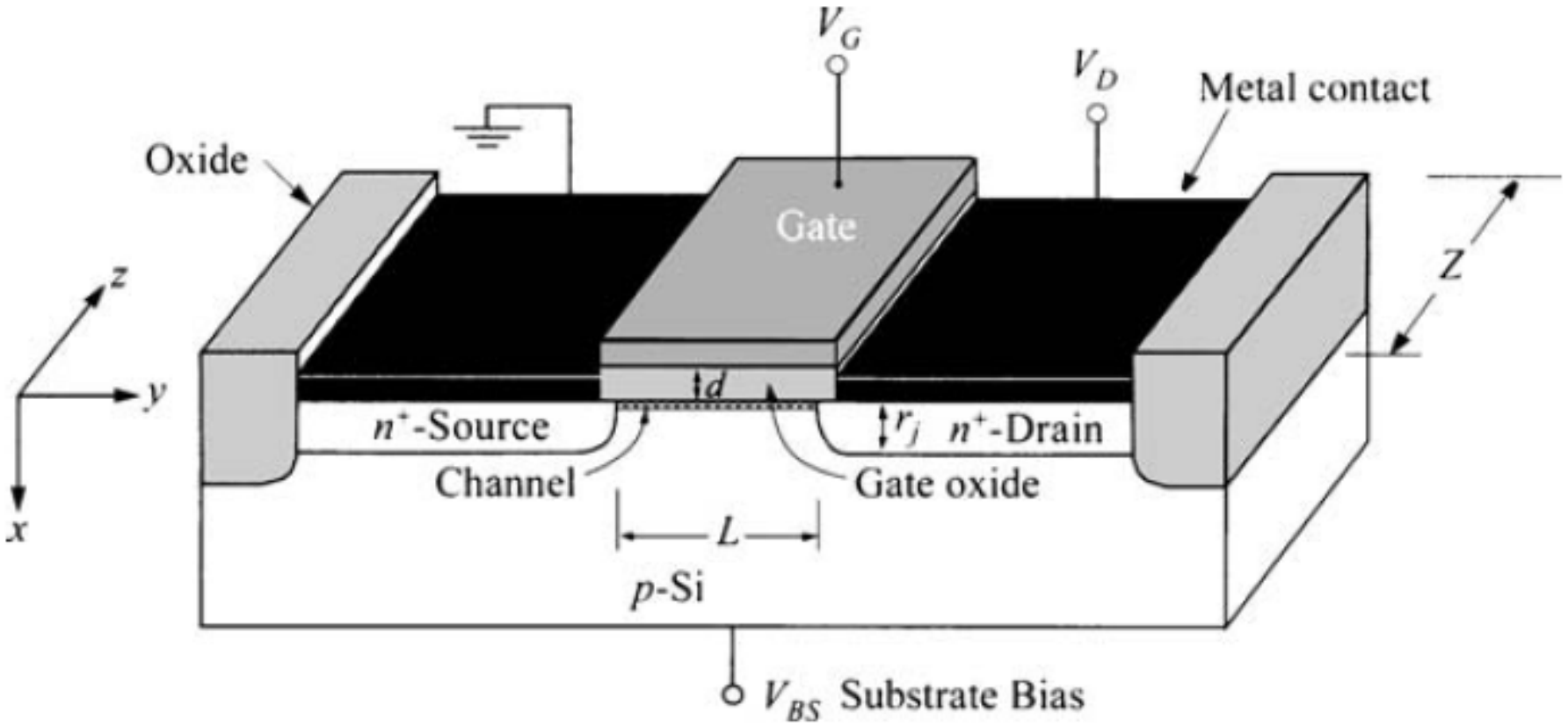


MOSFET, a legend

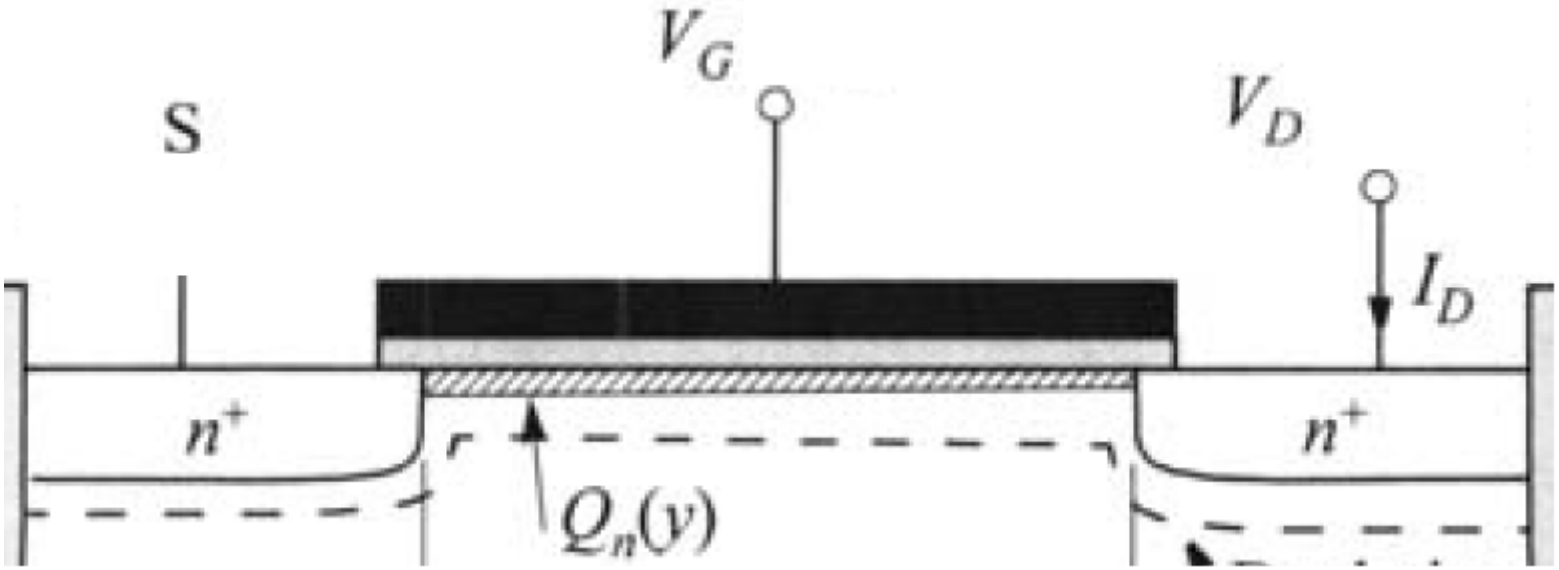
- While Shockley's JFET was greatest invention over BJT, for less off current, high input impedance, voltage controlled and temperature insensitive → Mead's MOSFET won JFET by exceedingly great reduce in off current and higher impedance…
- Over 50 years, the size was reduced about 1 lakh times, the latest MOSFET has over all size of 40nm.



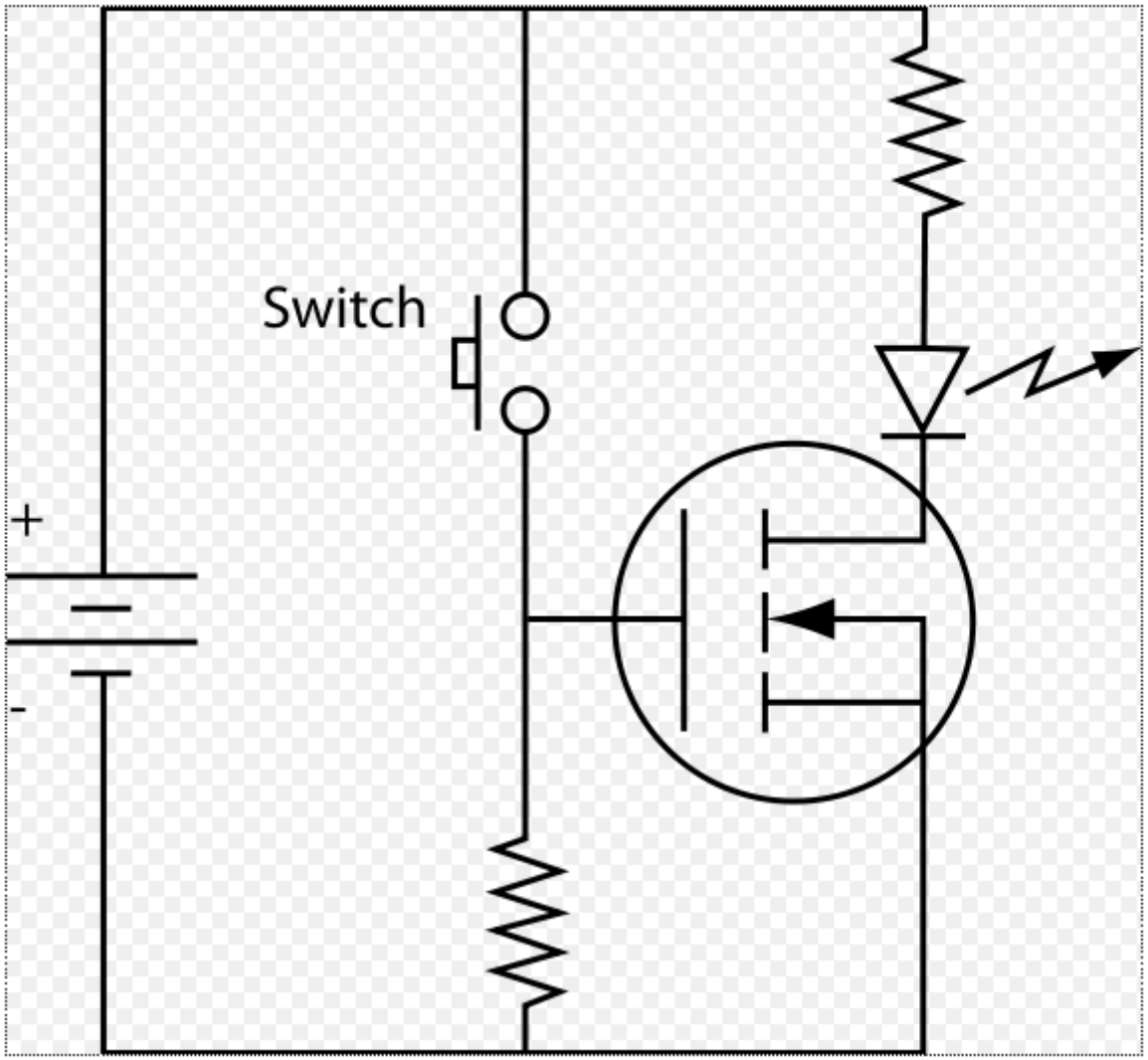
Device structure



Operation



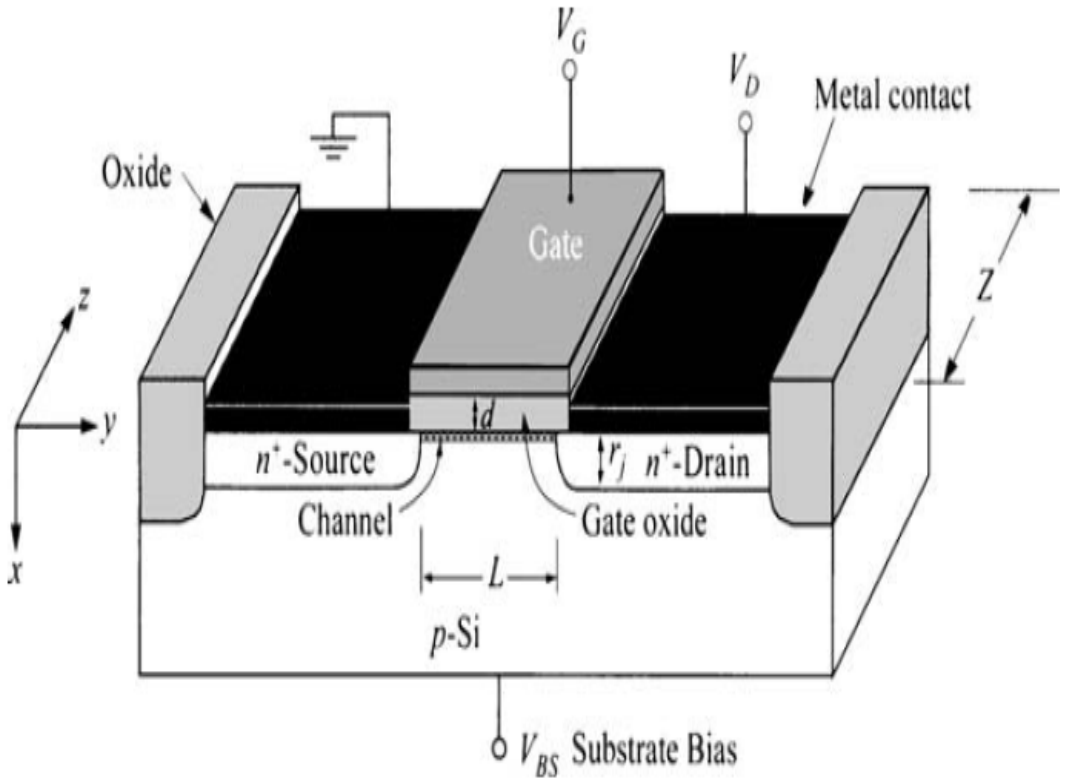
- While the Gate is positive higher voltage, which attracts the negative carriers (electrons) and will form a region below gate.
- Since this region inverted from p-type, it called as “Inversion region”. This region supports the flow of carriers from source to drain, so again called as “Channel”
- The channel width is depending on gate bias/potential which decides the drain current.
- The length of the gate metal is called “gate length” and length of the channel is called “Effective gate length”.

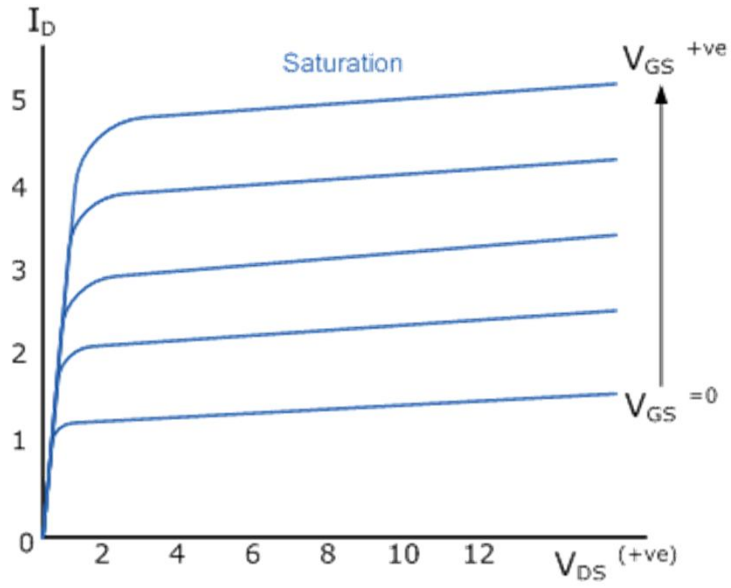

Switch
+
-

- Depending on the Gate voltage (V_{GS}> 0 and V_{GS}<0), the operation completely differs, they are respectively called “Enhancement Mode” and “Depletion Mode”

Enhancement type

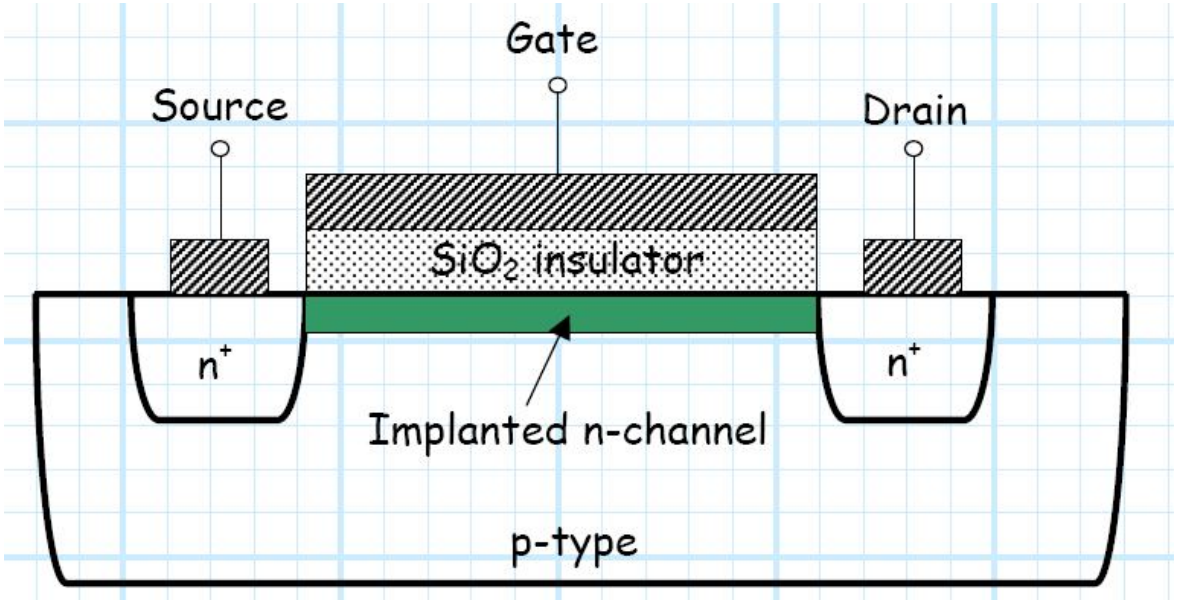
- The channel is formed normally without any added region.
- Normally OFF

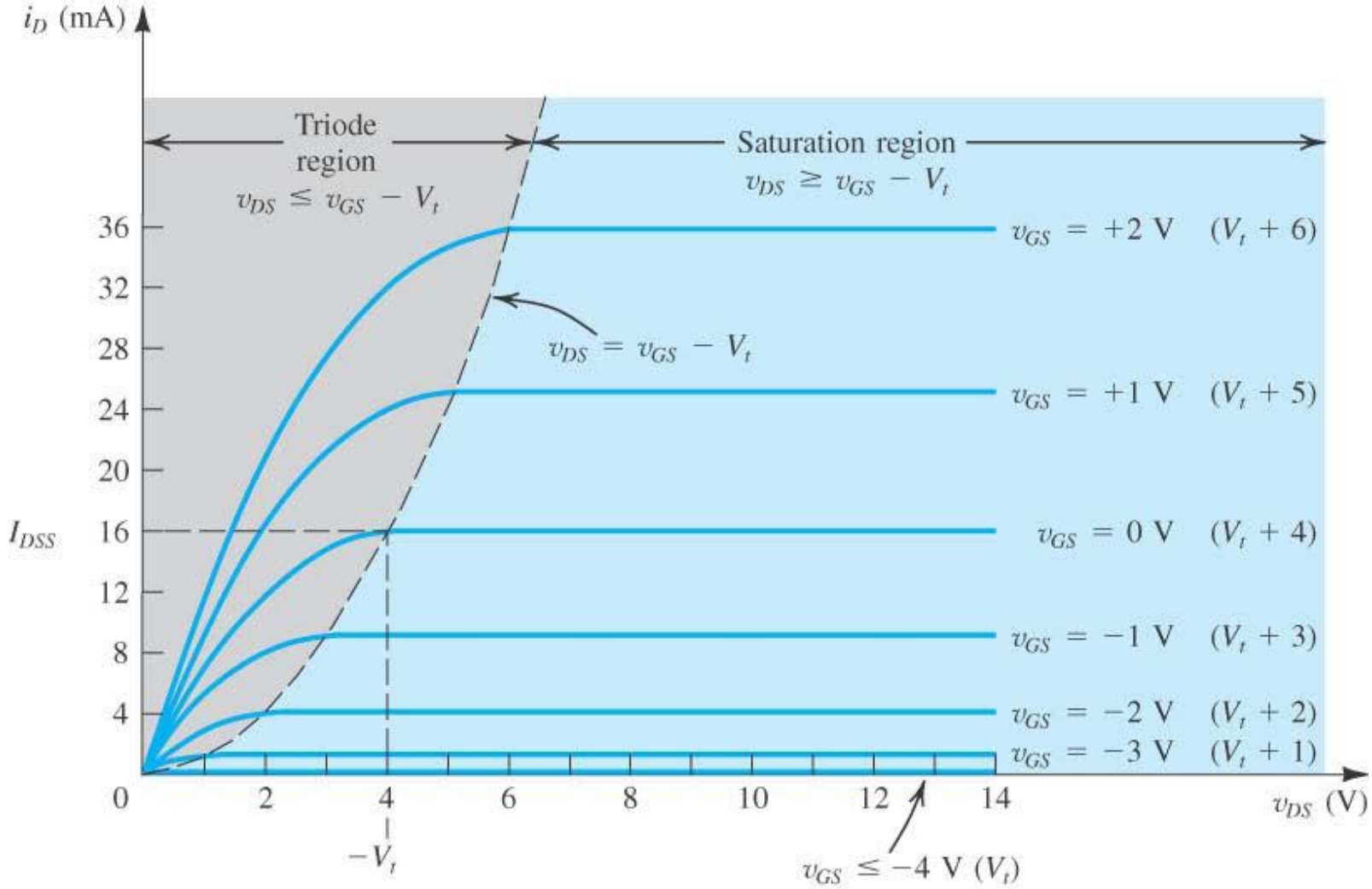




Depletion type

- Channel is depleted by forces Gate voltage
- Normally ON
- Most of the mobile applications.




i_D (mA)
Triode region
$v_{DS} \leq v_{GS} - V_t$
Saturation region
$v_{DS} \geq v_{GS} - V_t$
36
32
28
24
20
16
12
8
4
I_{DSS}
$v_{GS} = +2$ V $(V_t + 6)$
$v_{DS} = v_{GS} - V_t$
$v_{GS} = +1$ V $(V_t + 5)$
$v_{GS} = 0$ V $(V_t + 4)$
$v_{GS} = -1$ V $(V_t + 3)$
$v_{GS} = -2$ V $(V_t + 2)$
$v_{GS} = -3$ V $(V_t + 1)$
0
2
4
6
8
10
12
14
v_{DS} (V)
$-V_t$
$v_{GS} \leq -4$ V (V_t)