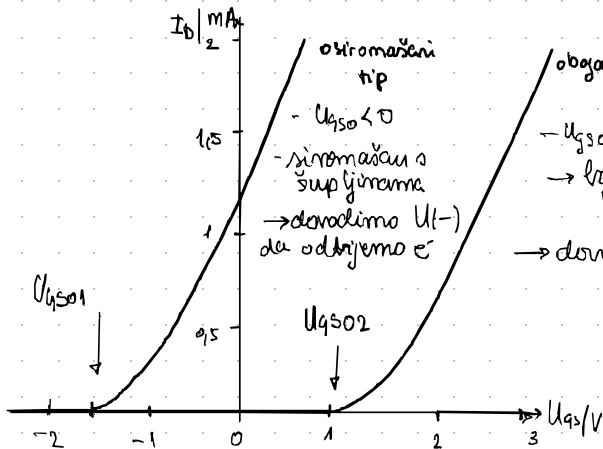


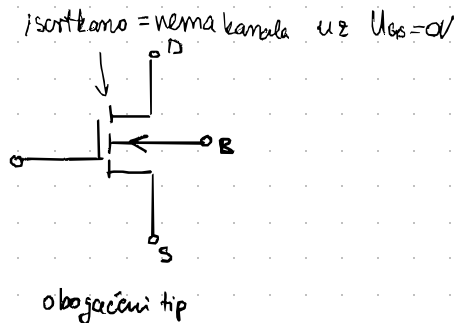
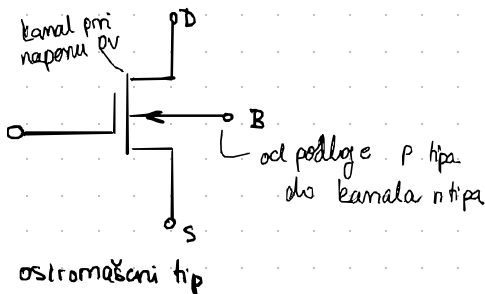
5.2 MOSFETI

Vrste n-kanalnih MOSFET-a



* n-kanalni MOSFET vodi struju uz $U_{gs} > U_{gs0}$

→ Simboli n-kanalnih MOSFETA



Primer 1.)

$t_{ox} = 20 \times 10^{-9} \text{ m}$ - debljina oksida

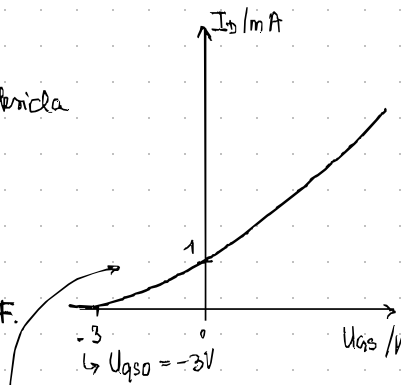
$\mu = 400 \text{ cm}^2/\text{Vs}$

a) $W/L = ?$

b) $L = ? \rightarrow C_g \leq 20 \text{ fF}$

$I_D = 1 \text{ mA} \rightarrow U_{gs} = 0 \text{ V}$ (iz grafa)

$I_D = 0 \text{ mA} \quad U_{gs} = U_{gs0} = -3 \text{ V}$



$U_{gs0} < 0 \rightarrow$ ostromašeni šupljina
- dovodimo $U(-)$
- odvojimo e^- privlaćimo $+$

\Rightarrow n-kanalni tranzistori:

$\mu_n = 400 \text{ cm}^2/\text{Vs}$

* $U_{gs} \uparrow, I_D \uparrow \rightarrow$ n-kanalni

kapacitet upravljanje elektr.

b) $L = ? \quad C_g = C_{ox} \cdot W \cdot L$

a) strujni koeficijent $K = \mu C_{ox} \left(\frac{W}{L} \right)$

$$C_{ox} = \frac{\epsilon_{ox}}{t_{ox}} = \frac{\epsilon_0 \cdot \epsilon'_{ox}}{t_{ox}}$$

$$\frac{W}{L} = \frac{K}{\mu \cdot C_{ox}}$$

$$\text{Zaricenje: } I_D = \frac{K}{2} (U_{gs} - U_{gs0})^2$$

$$10^{-3} \cdot 2 = K (0 + 3)^2$$

$$K = \frac{2}{9} 10^{-3}$$

$$\frac{W}{L} = \frac{\frac{2}{9} \times 10^{-3}}{400 \cdot \frac{\epsilon_0 \cdot \epsilon'_{ox}}{t_{ox}}}$$

$$\rightarrow \frac{W}{L} = 3.22 \times 10^{-12}$$

$$L = \frac{C_g}{C_{ox} \cdot W} = \frac{C_g}{C_{ox} \cdot 3.22 \times 10^{-12} \cdot L}$$

$$L^2 = \frac{C_g}{\frac{\epsilon_0 \cdot \epsilon'_{ox}}{t_{ox}} \cdot 3.22 \times 10^{-12}}$$

$$L = \sqrt{\frac{20 \times 10^{-15}}{\frac{\epsilon_0 \cdot \epsilon'_{ox}}{t_{ox}} \cdot 3.22 \times 10^{-12}}}$$

$$L = 1.9 \mu\text{m}$$

p-kanalni MOSTET

→ inverzijski sloj tvore ŠUPLJINE (p) →

* obrnuto od prej

→ p⁺ umesto n⁺
n podloga / p podloga

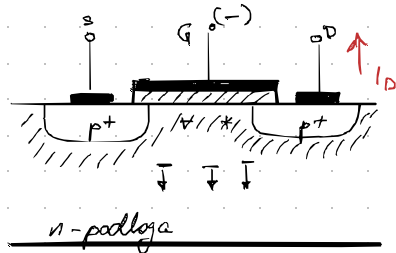
→ dovodimo NEGATIVAN (-) napon

odgovorno e⁻

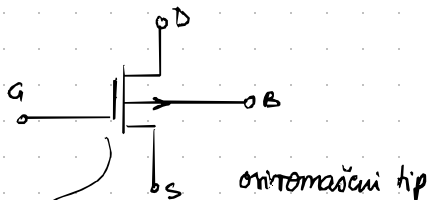
privlačno p⁺

→ na odvodu je tačkoter (-)

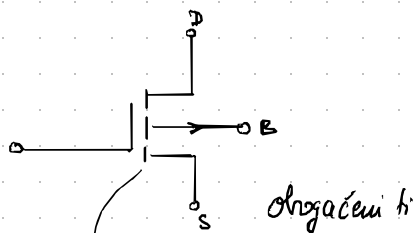
⇒ $I_D < 0$ jer "struja izlazi"



simboli p-kanalnih MOSFETA

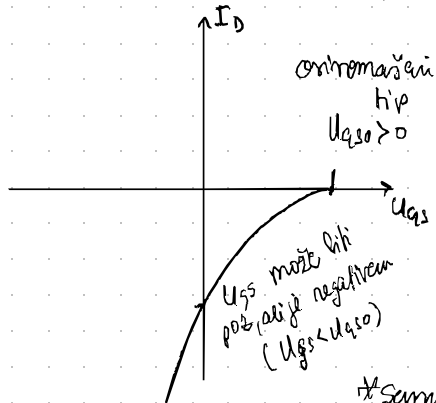


može postojati kanal ako nema napona na GATE-u

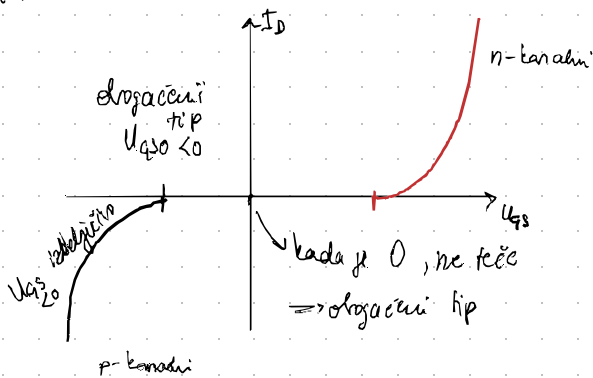


ne postoji kanal kad je napon na GATE-u 0V

* reč je formiranim kanal pri naponu 0V



* samo kraka od n-kanalnog



triobno područje: $U_{GS} - U_{GS0} \leq U_{DS} \leq 0$

$$I_D = K \left[(U_{GS} - U_{GS0}) U_{DS} - \frac{U_{DS}^2}{2} \right]$$

područje zasićenja: $U_{DS} \leq U_{GS} - U_{GS0}$

$$I_D = \frac{K}{2} (U_{GS} - U_{GS0})^2$$

područje zapiranja: $U_{GS} > U_{GS0}$

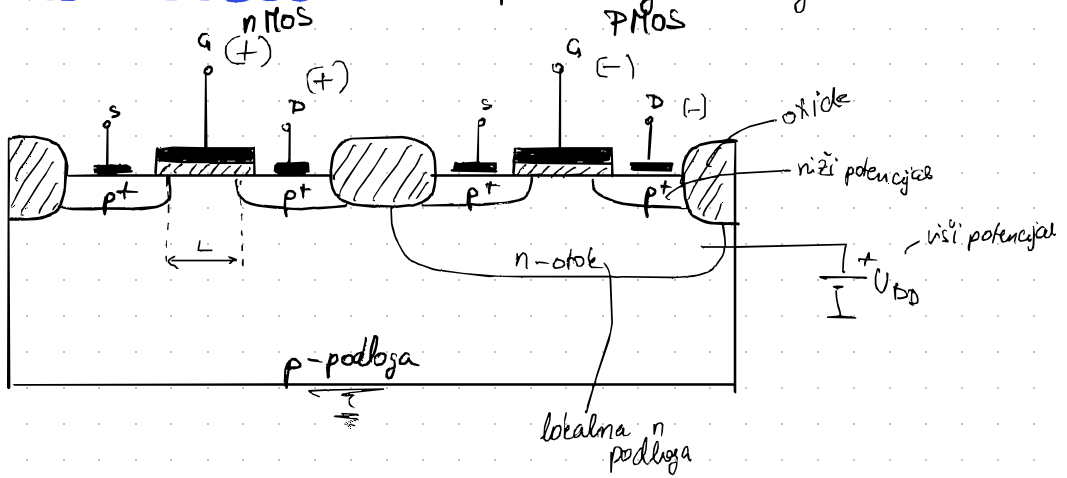
$$I_D = 0$$

koeffijent struje

$$K = -\mu_p C_{ox} \cdot \frac{W}{L}$$

CMOS struktura

complementary MOS (olyg) struktura



Primer $K = 0,4 \text{ mA/V}^2$

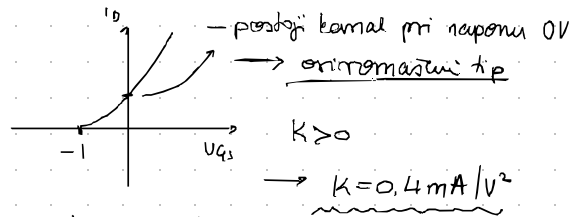
$$U_{q50} = -1 \text{ V}$$

→ natančni lastne karakteristike

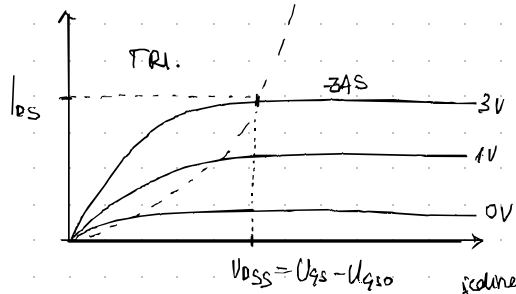
a) n-kanalni

b) p-kanalni

a) nMOS, $U_{q50} = -1 \text{ V}$



izlastne karakteristike:



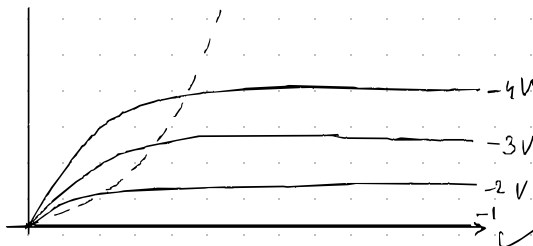
jedine U_{gs} koje
ima smisla gledati
su one $> U_{q50}$

$$I_D = \frac{K}{2} (U_{gs} - U_{q50})^2$$

$$U_{gs} = 0 \text{ V} \rightarrow I_D = \frac{K}{2} (0 + 1)^2$$

$$I_D = 0,2 \text{ mA}$$

$$I_D = \frac{K}{2} (U_{gs} - U_{q50})^2 \rightarrow \text{gledamo } U_{gs} < U_{q50}$$



lasti u zaprtaju kada je $U_{gs} > U_{q50}$!