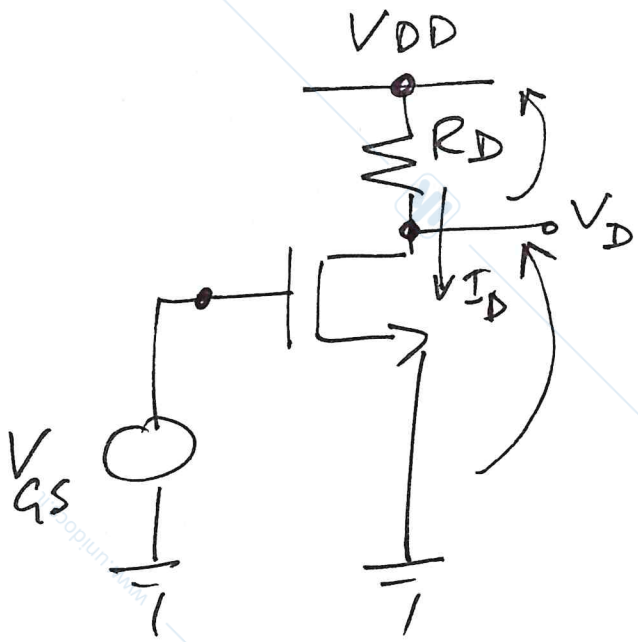
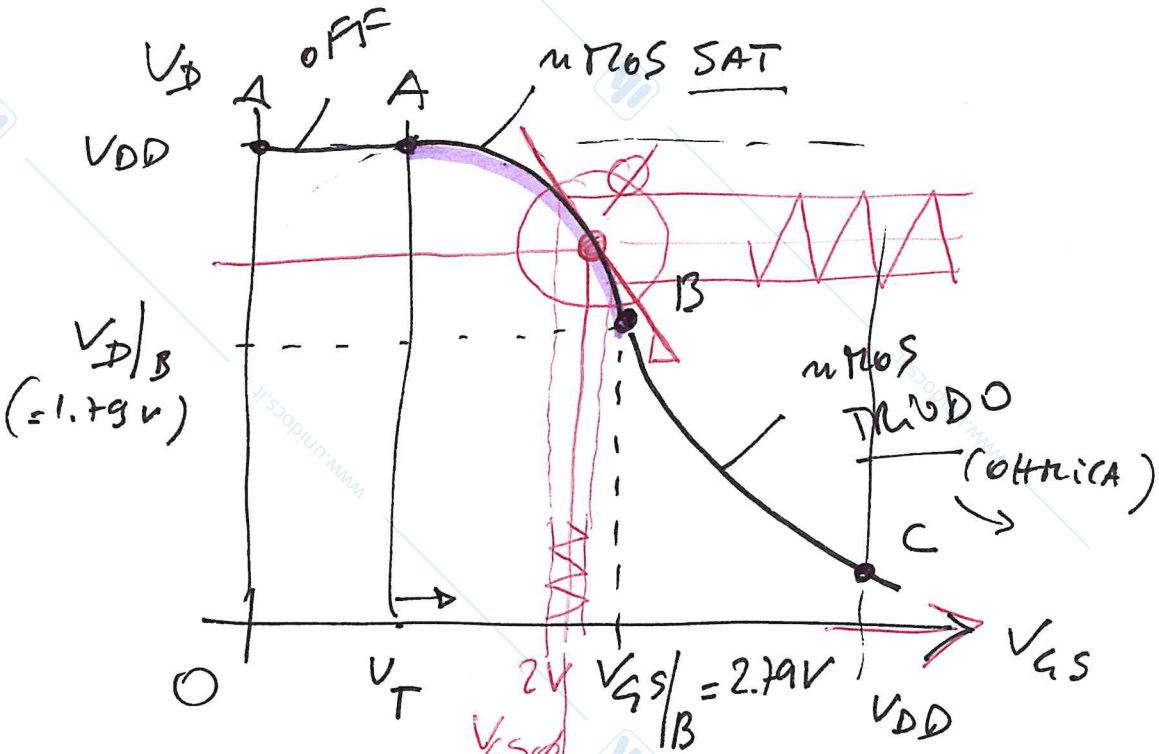
STADIO SOURCE A MASSA – FUNZIONAMENTO PER "PICCOLI SEGNALI"



$V_{DD} = 5V$
$R_D = 1k\Omega$
$K = 1 mA/V^2$
$V_T = 1V$



Tratto AB : nMOS saturo

$$\begin{cases} V_{DD} = V_D + R_D I_D \\ I_D = K(V_{GS} - V_T)^2 \end{cases} \Rightarrow$$

$$V_{DD} = V_D + R_D K (V_{GS} - V_T)^2$$

$$V_D = V_{DD} - R_D K (V_{GS} - V_T)^2$$

V_D = Y ; V_{GS} = X

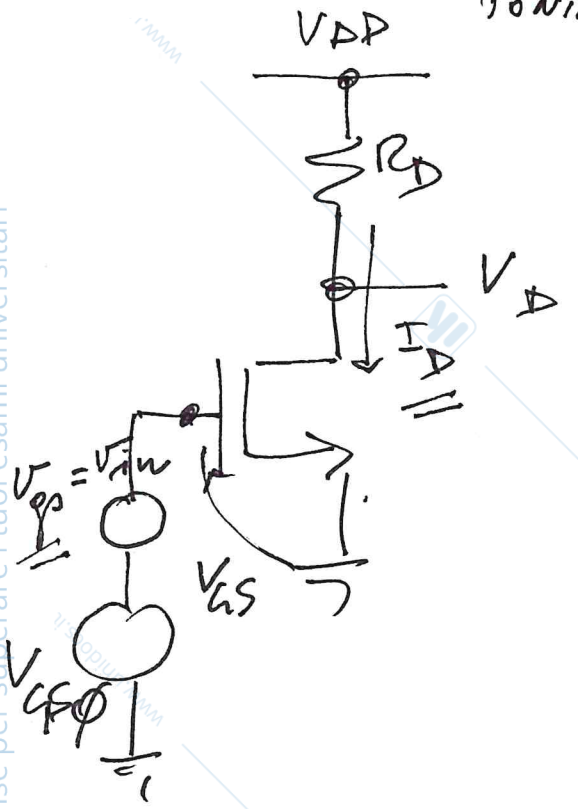
Cond. SAT: $V_D = V_{DS} \geq V_{GS} - V_T$

$\rightarrow V_D = V_{DD} - R_D K V_D^2$ $\xrightarrow{\text{ap. 2° gr.}}$ V_{D1}, V_{D2}

$= 1.79V$

$\rightarrow V_{GS}|_B = V_D|_B + V_T$

$$\left.\frac{dV_D}{dV_{GS}}\right|_{V_{GS}=V_{GS\phi}=2V} = -R_D K 2 (V_{GS} - V_T) = -1(k\Omega) \cdot 1\left(\frac{mA}{V^2}\right) \cdot 2 \cdot 1(V) = \boxed{-2}$$



PONIAMOCI NELLA CONDIZIONE IN CUI L'INGRESSO SIA COSTITUITO DA UN TERMINE COSTANTE (= POLARIZZAZIONE) E DA UN TERMINE DI "PICCOLO" SEGNALE.

$$V_{GS} = V_{GS\phi} + v_{gs} \qquad (v_{gs} = v_{in})$$

(MOS SATURO / TRANSFER CHARACTERISTIC)

$$I_D = k(V_{GS} - V_T)^2 = k\left(V_{GS\phi} + v_{gs} - V_T\right)^2 =$$

$$= k\left[(V_{GS\phi} - V_T) + v_{gs}\right]^2 =$$

$$= \underbrace{k(V_{GS\phi} - V_T)^2}_{I_{D\phi}} + \underbrace{2k(V_{GS\phi} - V_T)\cdot v_{gs}}_{i_d \text{ (lineare con } v_{gs}!)} + \underbrace{k v_{gs}^2}_{\text{non-lineare}}$$

$$k v_{gs}^2 \ll 2k(V_{GS\phi} - V_T)\cdot v_{gs}$$

CONDIZ. "PICCOLO SEGNALE"

$$|v_{gs}| \ll 2(V_{GS\phi} - V_T) \qquad 2(2V - 1V) = 2V$$

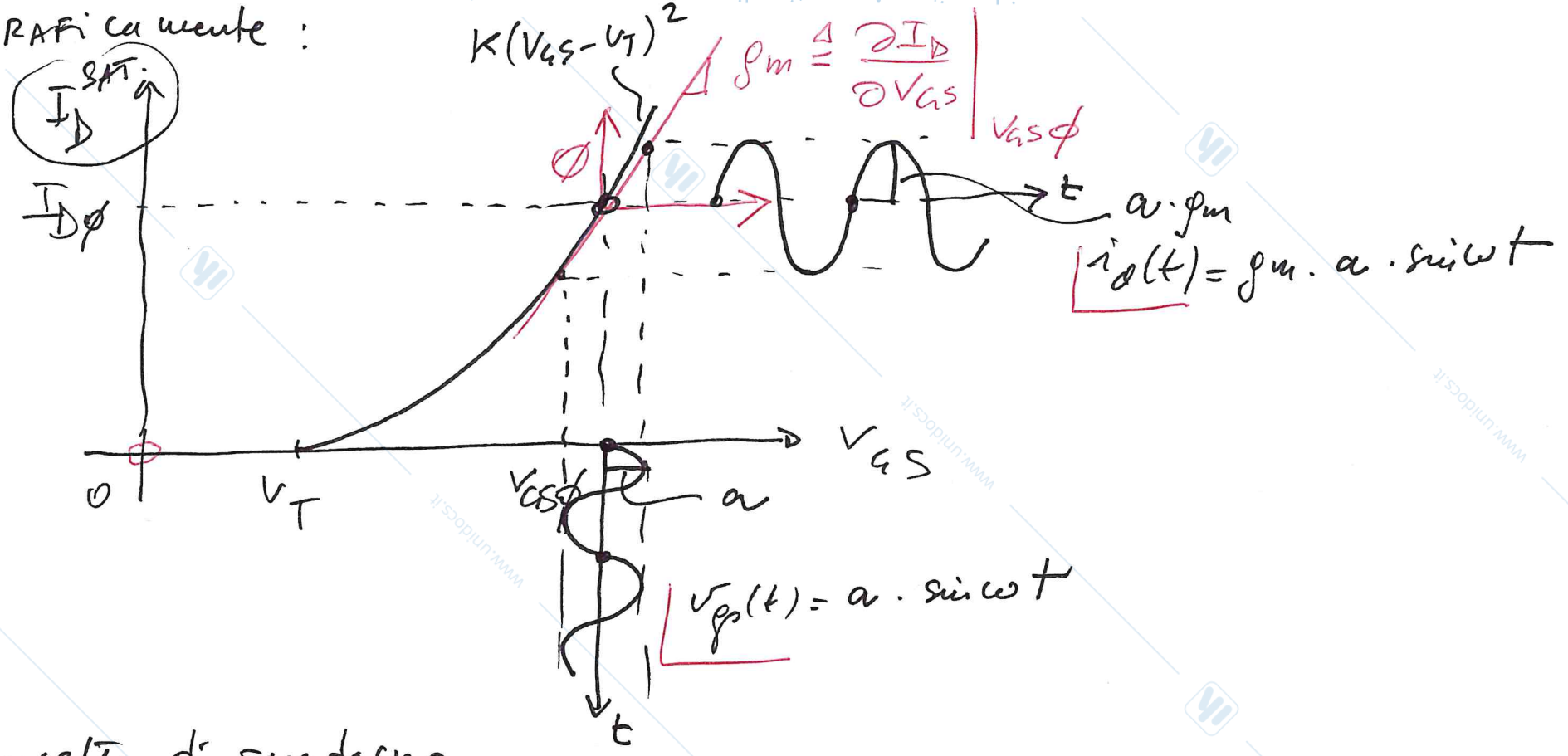
$$\Rightarrow i_d \simeq 2k(V_{GS\phi} - V_T)\cdot v_{gs}$$

$$\Rightarrow I_D = I_{D\phi} + i_d \simeq I_{D\phi} + \underbrace{2k(V_{GS\phi} - V_T)\cdot v_{gs}}_{i_d}$$

g_m TRANSCONDUTTANZA

$$g_m \triangleq \frac{i_d}{v_{gs}} = \left.\frac{\partial I_D}{\partial V_{GS}}\right|_{V_{GS} = V_{GS\phi}}$$

- GRAFICAMENTE:



- Concetto di guadagno

$$V_D = V_{DD} - R_D I_D = \underbrace{V_{DD} - R_D I_{D\phi}}_{V_{D\phi}} \underbrace{- R_D \cdot i_d}_{v_d}$$

$I_D = I_{D\phi} + i_d$

guadagno per "piccoli segnali"

$$\rightarrow \boxed{v_d} = -R_D \boxed{i_d} = -g_m R_D \cdot \boxed{v_{gs}} \Rightarrow \boxed{A_v} \triangleq \frac{v_d}{v_{gs}} = \boxed{-g_m R_D} \quad (-2)$$

$i_d = g_m v_{gs}$

v_o ← v_d ; v_{in} ← v_{gs}

$$g_m = 2k(V_{GS\phi} - V_T) = 2 \times 1 \frac{mA}{V^2} \times 1V = 2 \frac{mA}{V}$$