16/08/2019

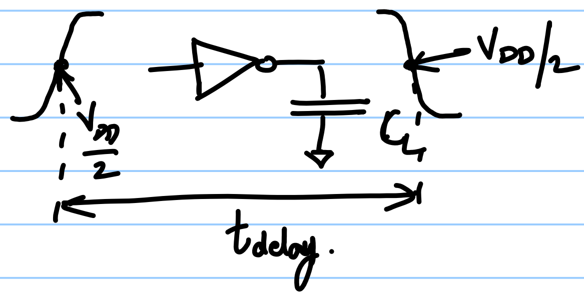
EE5311

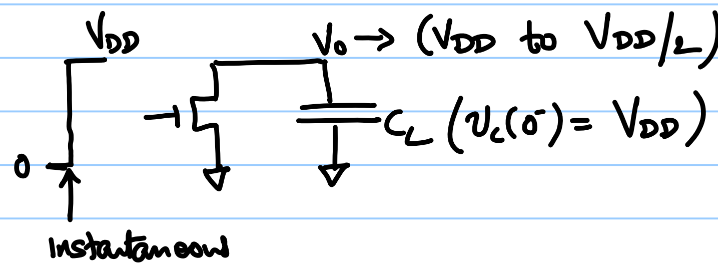
MODULE 1: THE TRANSISTOR

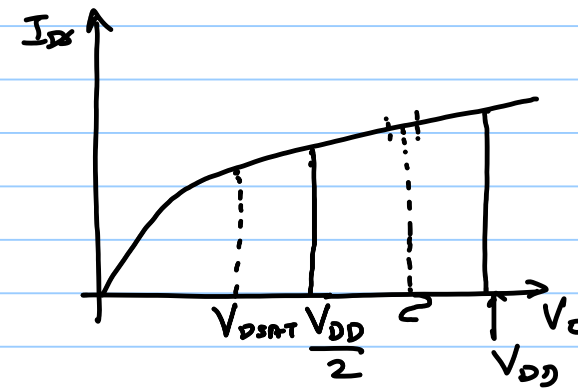
PMOS TRANSISTOR $\longrightarrow \{K'_p, \lambda_p, V_{DSATp}, V_{TOp}, \gamma_p\}$ all are -ve number.

$$I_{DS} = K'\frac{W}{L} V_{MAX}\left[(V_{GS}-V_T) - \frac{V_{MAX}}{2}\right](1+\lambda V_{DS})$$

CAPACITANCE CHARGING/DISCHARGING







$$I_{DS} = k_n' \frac{W}{L} V_{DSATn}\left[(V_{DD} - V_{Tn}) - \frac{V_{DSATn}}{2}\right](1 + \lambda V_0)$$

$$= I_0 (1 + \lambda V_0)$$

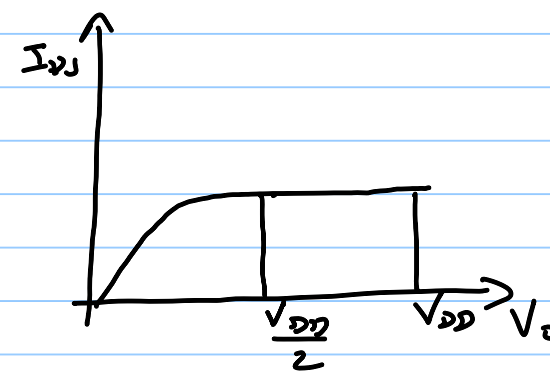
$$R(V_o) = \frac{V_o}{I_o(1+\lambda V_o)}$$

$$R_{eq} = \frac{1}{(V_f - V_i)} \int_{V_i}^{V_f} R(V_o)\, dV_o \sim \frac{1}{(-V_{DD}/2)} \int_{V_{DD}}^{V_{DD}/2} \frac{V_o}{I_o} (1 - \lambda V_o)\, dV_o$$

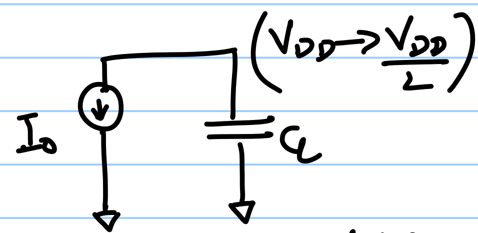
$$= \frac{1}{I_o} \cdot \frac{2}{V_{DD}} \int_{V_{DD}/2}^{V_{DD}} V_o (1 - \lambda V_o)\, dV_o$$

$$= \frac{3}{4} \frac{V_{DD}}{I_o} - \frac{7}{12} \frac{\lambda V_{DD}^2}{I_o}$$

$$\Rightarrow \quad R_{eq} = \frac{3}{4} \frac{V_{DD}}{I_o} \quad (\text{if } \lambda = 0)$$

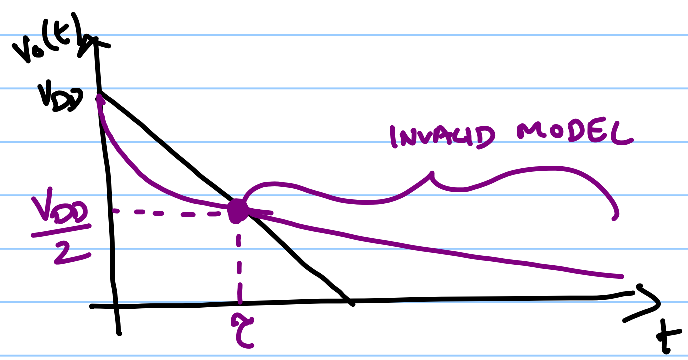


METHOD 2:

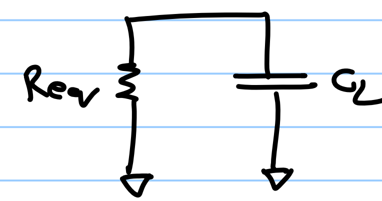


$$V_o(t) = V_{DD} - \frac{I_o}{C} t \leftarrow$$

$$\tau = \frac{C_L \Delta V}{I_o} = \frac{C_L (V_{DD}/2)}{I_o}$$



METHOD 1:



$$V_o(t) = V_{DD} e^{-t/\tau'}$$

$$R_{eq} = \frac{3}{4} \frac{V_{DD}}{I_o}$$

$$\Rightarrow \tau' = R_{eq} C$$

$$\tau = 0.693 \cdot \frac{3}{4} \frac{V_{DD} C_L}{I_o} \approx 0.5 \frac{V_{DD} C_L}{I_o}$$

$$R_{eq} = \frac{3}{4}\frac{V_{DD}}{I_o}$$

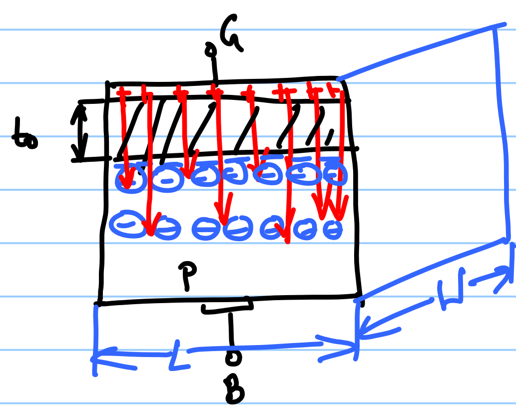
$$I_o = \begin{cases} k_n' \frac{W}{L} V_{DSATn}\left[(V_{DD} - V_{Tn}) - \frac{V_{DSATn}}{2}\right] & \hookrightarrow \text{VEL SAT (SC)} \\ \frac{1}{2} k_n' \frac{W}{L} (V_{DD} - V_T)^2 & - \text{SAT (LONG)} \end{cases}$$

$$R_{eq} \propto \frac{1}{W}$$

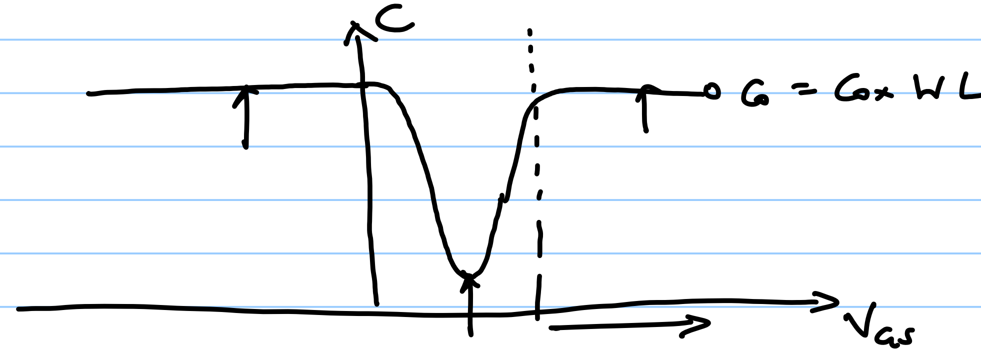
if V_{DD} LARGE ie $V_{DD} - V_{Tn} - \frac{V_{DSATn}}{2} \sim V_{DD}$

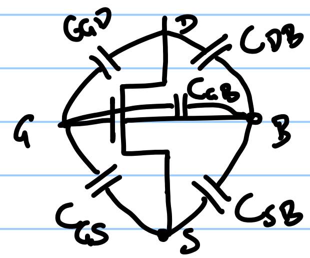
R_{eq} not a fn of V_{DD}

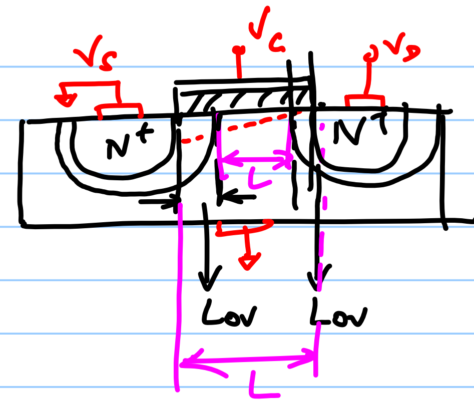
CAPACITANCE:



$C_0 = C_{ox} W L$







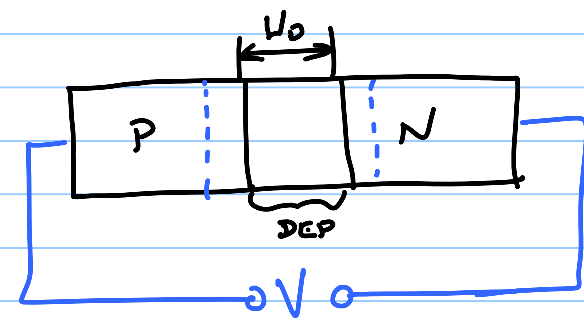
$$C_G = \underline{C_{GS}} + \underline{C_{GD}} + C_{GB} = C_{ox} \cdot WL \rightarrow C_0$$

$$C_{ov} = C_{ox} \cdot W \cdot L_{ov}$$

$$\text{TOTAL GATE CAP} = C_G + 2C_{ov} = (C_{ox} \cdot W\underline{L} + 2C_{ox} \cdot W \cdot L_{ov})$$

$$= W(C_{ox} \cdot L + 2C_{ox} L_{ov})$$

$\underline{C_{DB}}$ & $\underline{C_{SB}}$



$V < 0 \Rightarrow C \downarrow$