

05/08/2019

EES311

$$I_{Ds} = \begin{cases} \mu_n C_{ox} \frac{W}{L} V_{Ds} [(V_{Gs} - V_T) - V_{Ds}/2] & V_{Ds} \leq V_{Gs} - V_T \\ \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{Gs} - V_T)^2 & V_{Ds} > V_{Gs} - V_T \\ \sim 0 & V_{Gs} < V_T \end{cases}$$

NPTTEL

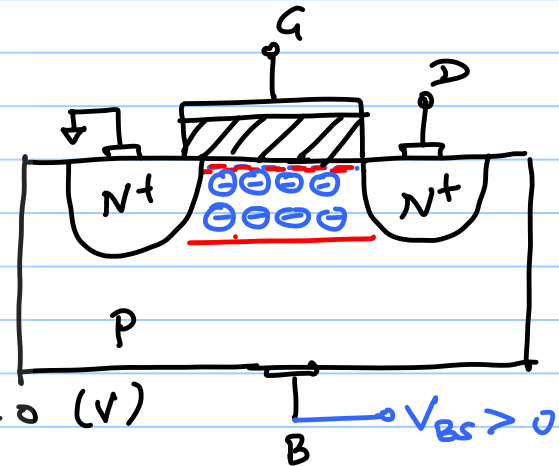
## BODY EFFECT

$$V_{TH} = \psi_s + \frac{1}{C_{ox}} \sqrt{2\epsilon_s q N_A |\psi_s|} \leftarrow$$

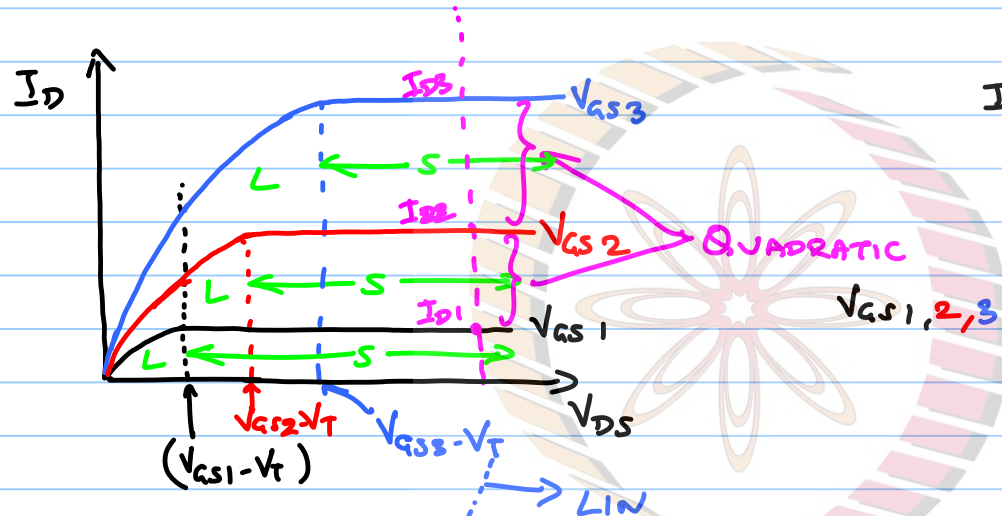
$$\underline{V_{TH}} = V_{TH0} + \gamma (\sqrt{|\psi_s + V_{SB}|} - \sqrt{|\psi_s|})$$

$V_{TH0} \rightarrow$  THRESHOLD VOLTAGE @  $V_{SB} = 0$  (V)

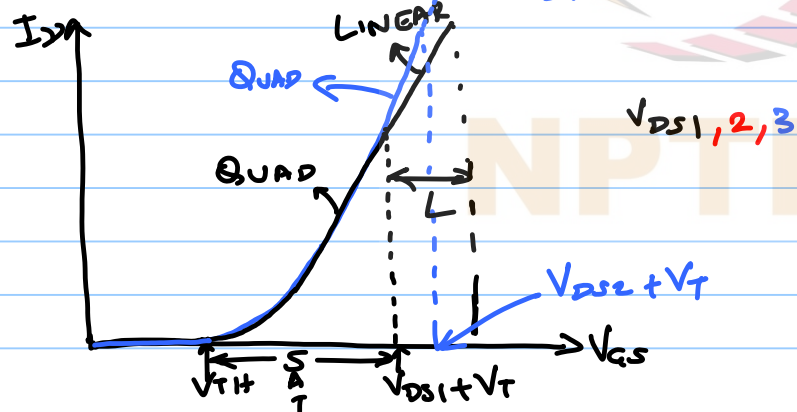
$\gamma \rightarrow$  BODY EFFECT COEFF  $> 0$  (for NMOS)  $\Rightarrow V_{TH} \downarrow$   
( $\sqrt{V}$ )



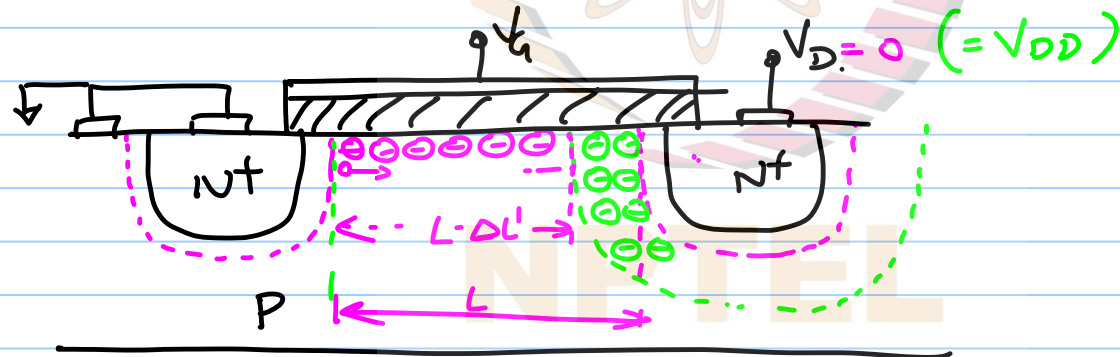
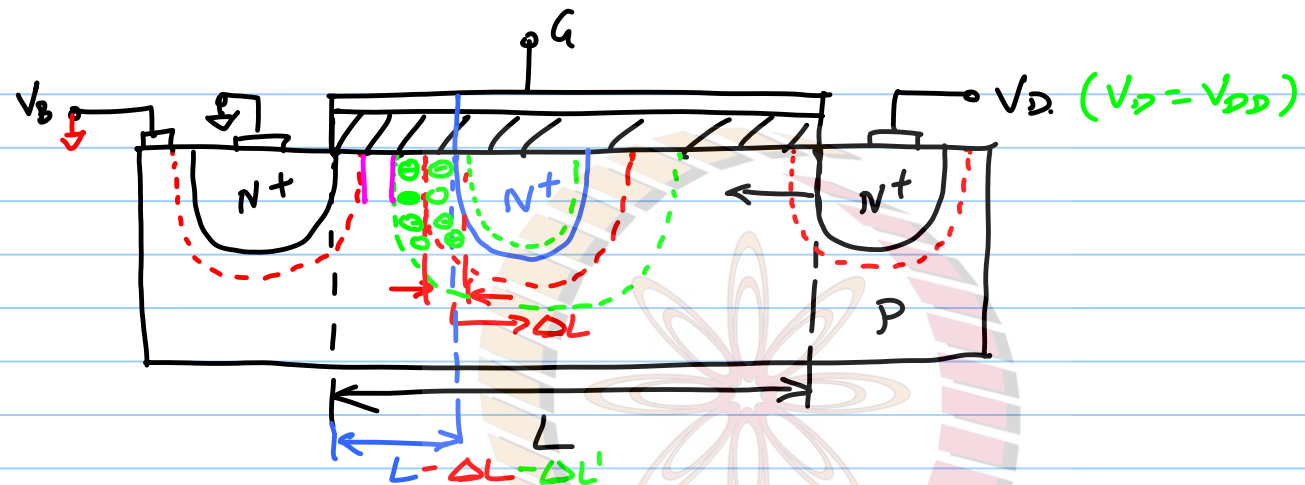
NPTEL



$$I_D = \begin{cases} \mu_n C_{ox} \frac{W}{L} V_{DS} \left[ \frac{V_{GS} - V_T}{2} - \frac{V_{DS}}{2} \right] & V_{DS} \leq V_{GS} - V_T \\ \mu_n C_{ox} \frac{W}{2L} (V_{GS} - V_T)^2 & V_{DS} > V_{GS} - V_T \end{cases}$$



$$V_{DS} > V_{GS} - V_T$$



### SHORT CHANNEL EFFECT:

#### CHANNEL LENGTH MODULATION: (CLM)

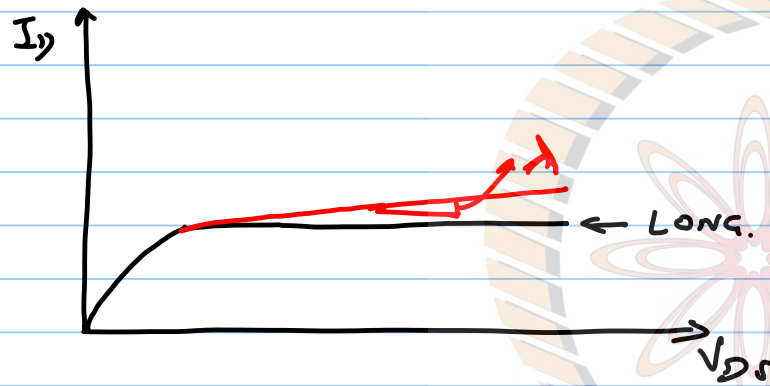
$$I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 \quad (\text{LONG CHANNEL EQN } \neq f(V_{DS}))$$

$$L \rightarrow (L - \Delta L)$$

$$I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{(L - \Delta L)} (V_{GS} - V_{TH})^2 = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 \left(1 + \frac{\Delta L}{L}\right)$$

$$\Rightarrow I_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{TH})^2 (1 + \lambda V_{DS})$$

$\downarrow$   
 $\lambda V_{DS}$   
 $\downarrow$   
CLM PARAM



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