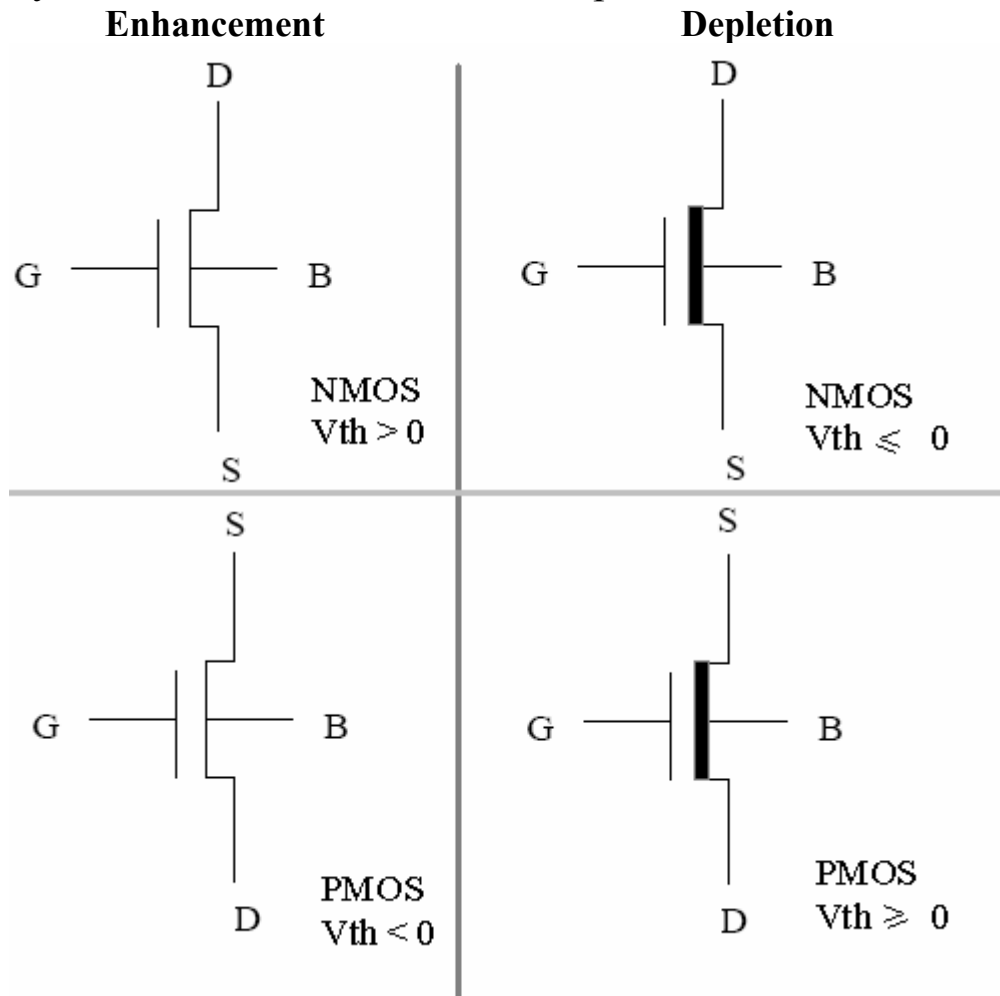


Symbols for Enhancement and Depletion MOSFET:



MOSFET channel length modulation:

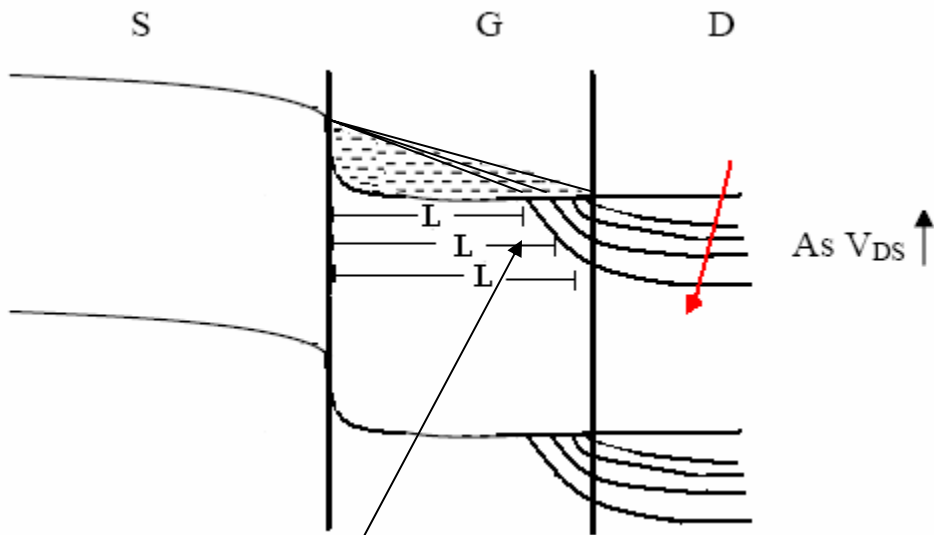
- The Drain Current saturation region (i.e. $V_{DS} \geq V_{GS} - V_{th}$) has slight dependency on V_{DS} due to channel length modulation by V_{DS}

Ideally

$$I_{D_{sat}} = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{th})^2$$

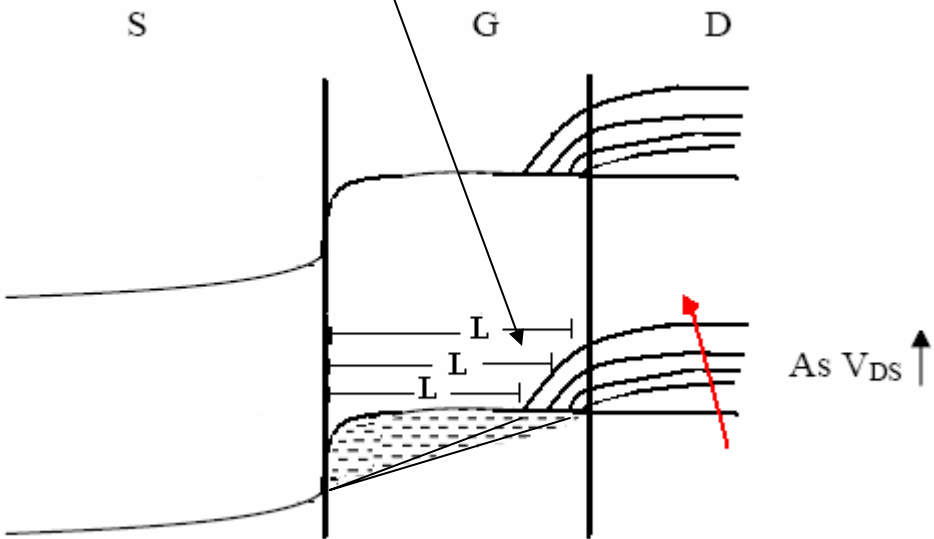
L is affected by V_{DS}

Using Energy-Band diagrams, For NMOS



Channel length modulation

For PMOS



As V_{DS} increases \rightarrow L decrease \rightarrow I_{DS} increases (NMOS)
 As V_{SD} increases \rightarrow L decrease \rightarrow I_{SD} increases (PMOS)

For circuit analysis, we can express the saturation current as:

$$I_{D_{\text{sat}}} = \frac{1}{2} \mu_n C_{\text{ox}} W/L (V_{\text{GS}} - V_{\text{th}})^2 (1 + \lambda V_{\text{DS}})$$

where

λ =channel length modulation coefficient.

- The effect on the transistor I - V characteristics :

