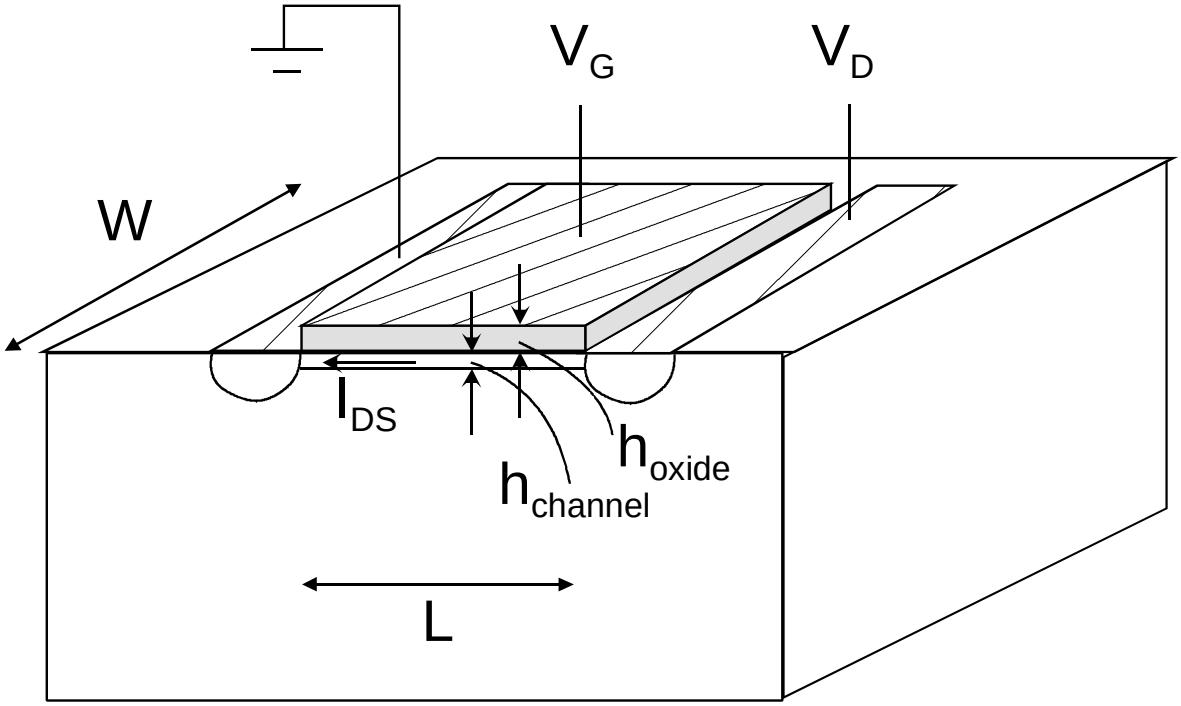
Derivation of MOSFET current-voltage relationship in linear region-



$Q_{channel} = C_{oxide}(V_G - V_T)$ $\quad (C_{oxide} = \frac{\varepsilon_{oxide} WL}{h_{oxide}},\ \varepsilon_{oxide} = \varepsilon_{r,oxide}\varepsilon_0)$

$Q_{channel} = NeWLh_{channel}$

$$I_{DS} = jWh_{channel} = Nev Wh_{channel} = (\frac{Q_{channel}}{WLh_{channel}})(\mu \mathrm{E})Wh_{channel} = (\frac{Q_{channel}}{L})(\mu \mathrm{E}) = (\frac{Q_{channel}\mu}{L^2})V_D$$

Substituting for $Q_{channel}$,

$$I_{DS} = (\frac{C_{oxide}(V_G - V_T)\mu}{L^2})V_D$$