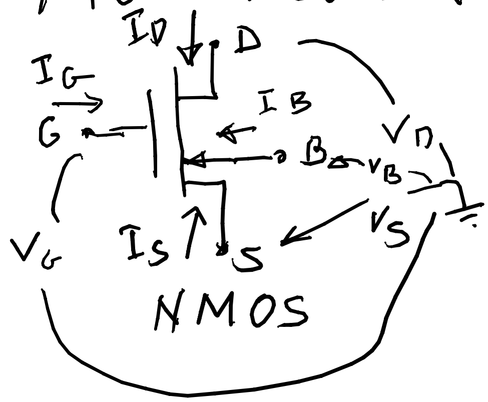
MOS model

M

EE302
02/08/05

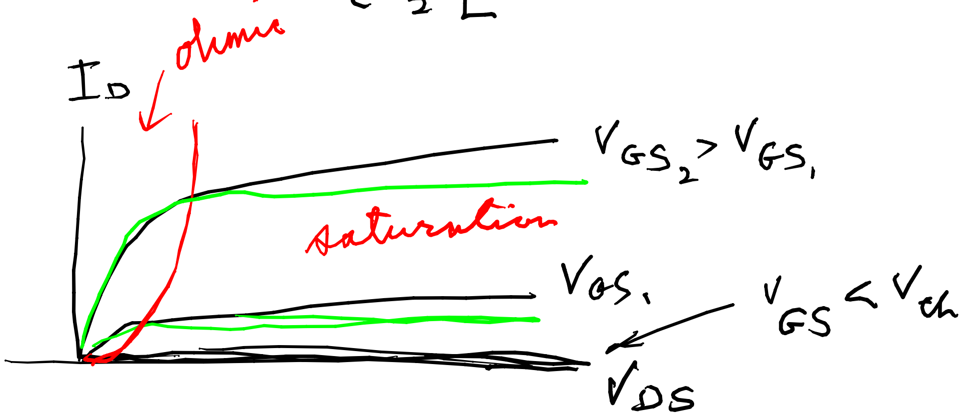


D = drain if voltage at D is larger than voltage at S (if reverse then D → source, S → drain

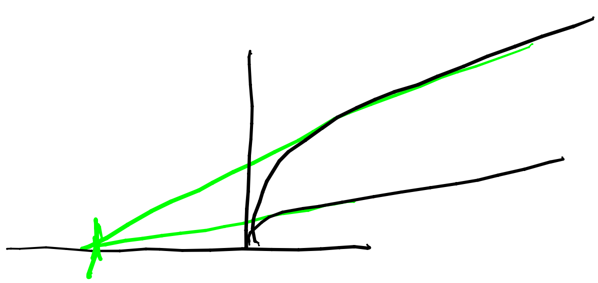
at DC, $I_G \equiv 0$ if B tied to S then $I_B = 0$

P.260

$$I_D = \begin{cases} 0 & V_{GS} < V_{th} \quad \text{off} \\ \frac{KP}{2}\frac{W}{L}(V_{GS}-V_{th})^2(1+\lambda V_{DS}) & \text{if } V_{DS} \geq V_{GS}-V_{th} \geq 0 \\ \frac{KP}{2}\frac{W}{L}\left(2(V_{GS}-V_{th})V_{DS} - V_{DS}^2\right)(1+\lambda V_{DS}) & V_{GS}-V_{th} \geq V_{DS} \geq 0 \end{cases}$$



if $V_{BS} = 0$ then $V_{th} = VTO$ in Spice



$-V_A = -\frac{1}{\lambda} = -\frac{1}{\text{lambda}}$

for MNMOSIS: $KP = 5.048 \times 10^{-5}\ A/V^2$; $\lambda = 1.843384 \times 10^{-2}\ \frac{1}{V}$
$VTO = 0.858153\ V$ $\gamma = 0.198$

for MPMOSIS: $KP = 1.908 \times 10^{-5}\ A/V^2 < KP_{nchannel}$

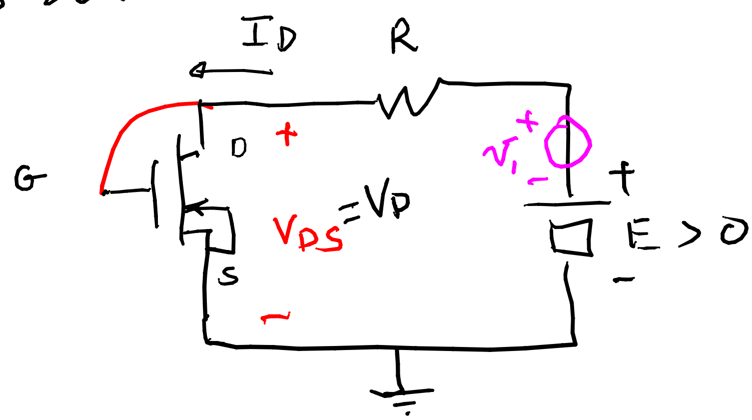
$VTO = -0.88927\,V$; $|VTO_p| > |VTO_n|$

$\lambda = 5.011620 \times 10^{-2}\ \frac{1}{V}$ $\quad \gamma = 0.6289$

for V_{th} va VTO, eq. (4.33) p. 258 (Body effect)

$$V_{th} = VTO + \gamma\left(\sqrt{2\phi_F + V_{SB}} - \sqrt{2\phi_F}\right)$$

MOS diode



here $V_{th} = VTO$

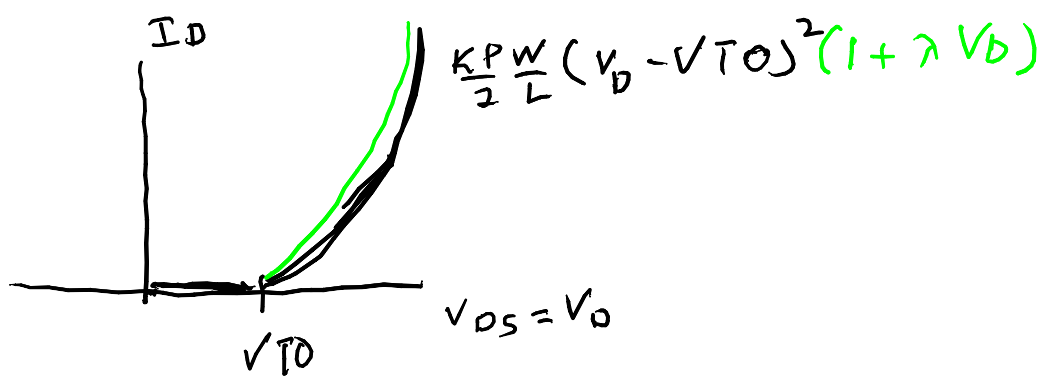
if $VTO = 0.88$ then if G = S no current will flow

here $V_{GS} = V_{DS}$

or $V_{GS} - VTO < V_{DS}$

if $V_{GS} > VTO$ then turned on and in saturation region

$$I_D = \begin{cases} 0 & 0 \le V_{DS} = V_{GS} < VTO \\ \frac{KP}{2}\frac{W}{L}(V_{DS} - VTO)^2, & V_{DS} > VTO \end{cases}$$

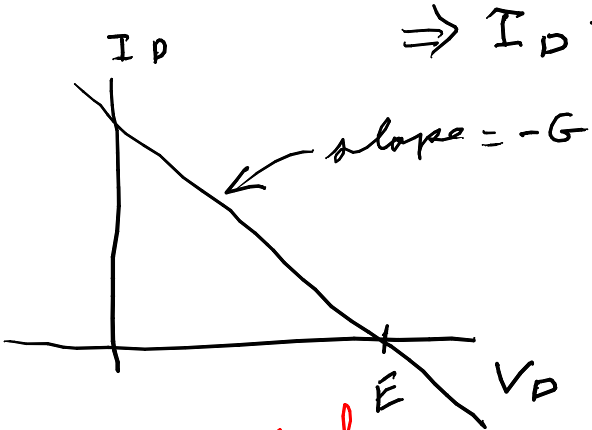


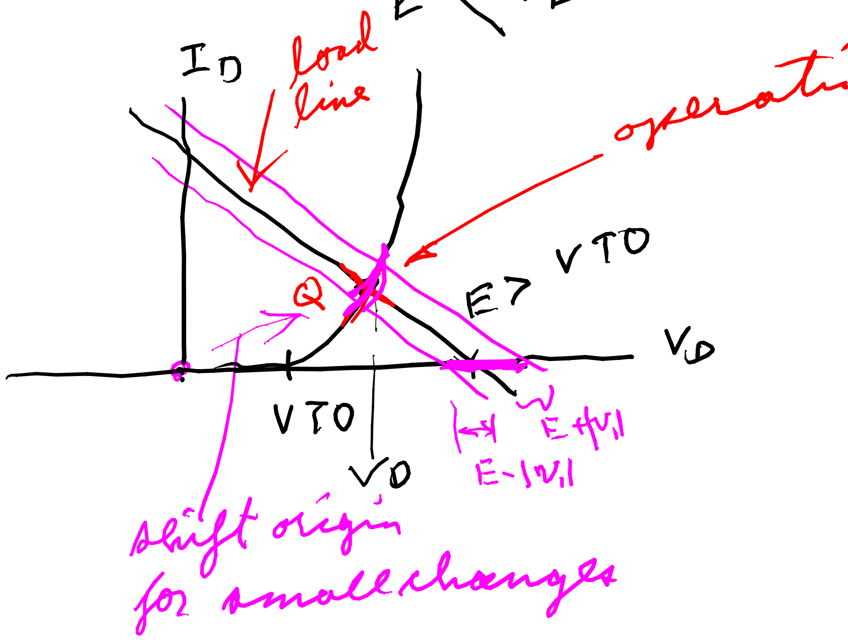
for right hand side $V_D = -RI_D + E$

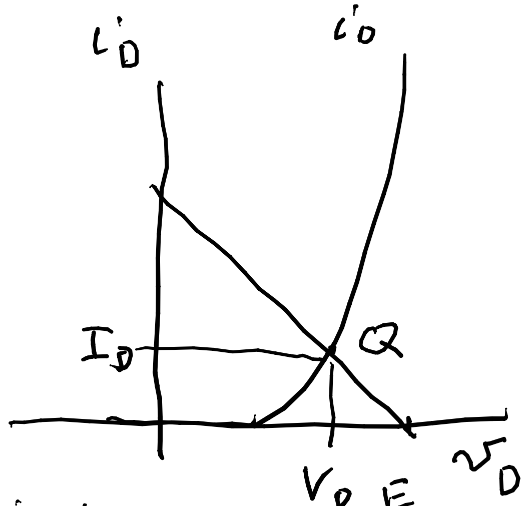
$$\Rightarrow I_D = -\frac{1}{R}(V_D - E) = -GV_D + E/R$$

$$= -G(V_D - E)$$

$$G = 1/R$$



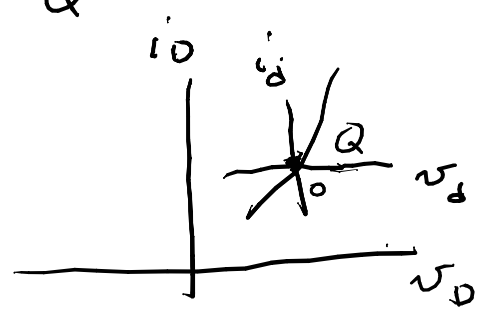




Taylor series expansion

$$i_D = I_D + \frac{\partial i_D}{\partial v_D}\Big|_Q (v_D - V_D) + \frac{\partial^2 i_D}{\partial v_D^2}\Big|_Q (v_D - V_D)^2 + \cdots$$

(i_D ↑ total current; I_D ↑ at Q pt)



$$\therefore \quad i_d = i_D - I_D = \frac{\partial i_D}{\partial v_D} v_d \Rightarrow$$

$$i_d = g_d \, v_d$$

$$i_D = \frac{KP}{2}\frac{W}{L}(v_D - VTO)^2 \; ; \quad g_d = KP\frac{W}{L}(v_D - VTO)\Big|_{V_D}$$

small signal equivalent $= KP\frac{W}{L}(V_D - VTO)$