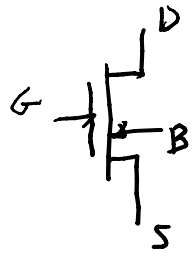
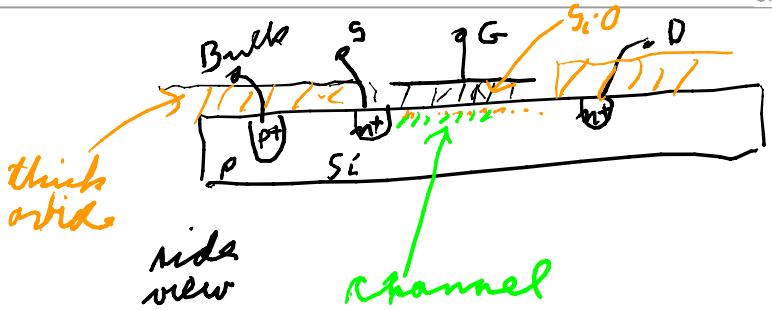
EE 303H
09/24/13
→ (25) for V_{th}

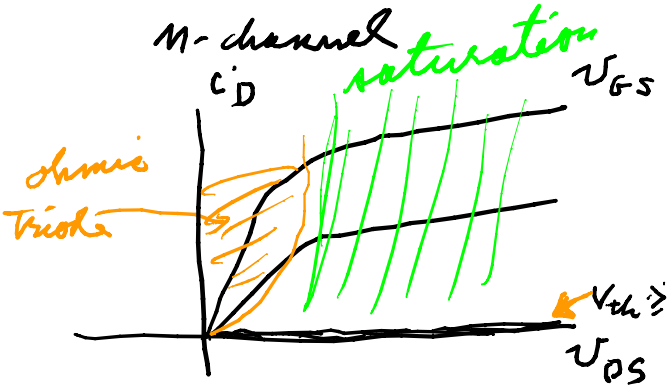
Note Title 9/24/2013

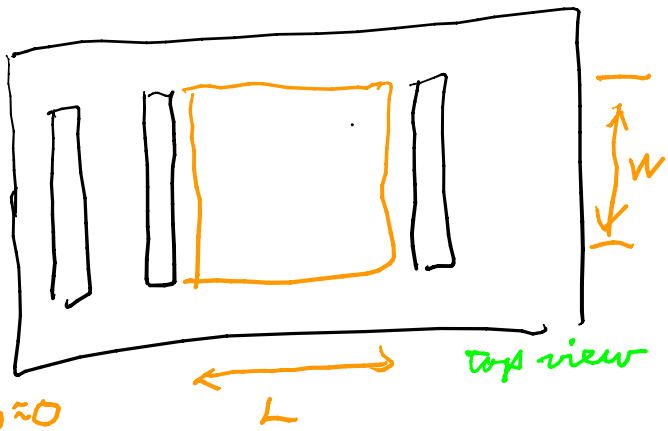
MOS, p. 253 = picture

pp. 354-355 eqs









V_{th} = threshold voltage = V_{TO} if $v_{BS} = 0$

$$i_D = \frac{KP}{2}\cdot\frac{W}{L}\times\begin{cases} 0 & \text{if } v_{GS} \leq V_{th} \quad \text{cutoff} \\ (v_{GS}-V_{th})^2(1+\lambda v_{DS}) & \text{if } v_{GS} \geq V_{th},\ v_{GS}-V_{th} \leq v_{DS} \quad \text{saturation} \\ \left[2(v_{GS}-V_{th})v_{DS}-v_{DS}^2\right](1+\lambda v_{DS}) & \text{if } v_{GS} \geq V_{th},\ v_{GS}-V_{th} \geq v_{DS} \end{cases}$$

here $V_{th} = V_{TO} + \gamma\left(\sqrt{-v_{BS}+2\phi_f} - \sqrt{2\phi_f}\right)$

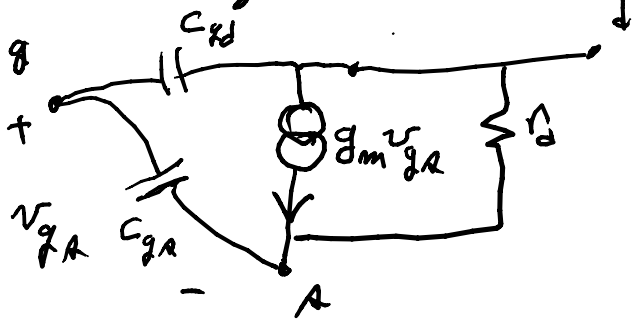
(p. 324)

SPICE parameters

$2\phi_f \approx 2/3$ for NMOS
$\approx 3/4$ for PMOS

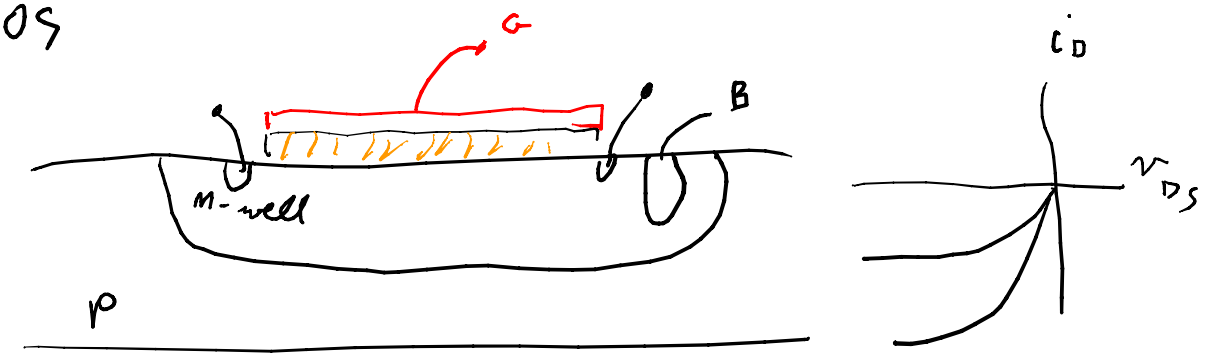
$[v_{BS_n} \rightarrow v_{SB_p}]$

Equivalent small signal circuit



c's are proportional to W×L

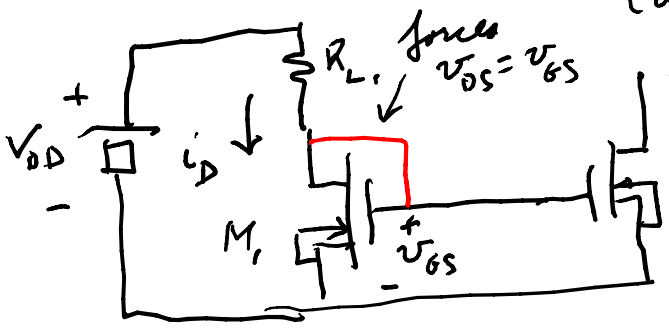
For PMOS



interested in g_m & g_d ; in saturation region

$$g_m = \left.\frac{\partial i_D}{\partial v_{GS}}\right|_Q = \frac{2I_D}{(V_{GS}-V_{th})} \quad , \quad g_d = \left.\frac{\partial i_D}{\partial v_{DS}}\right|_Q = \lambda \frac{I_D}{1+\lambda V_{DS}} \approx \lambda I_D$$

Current Mirrors

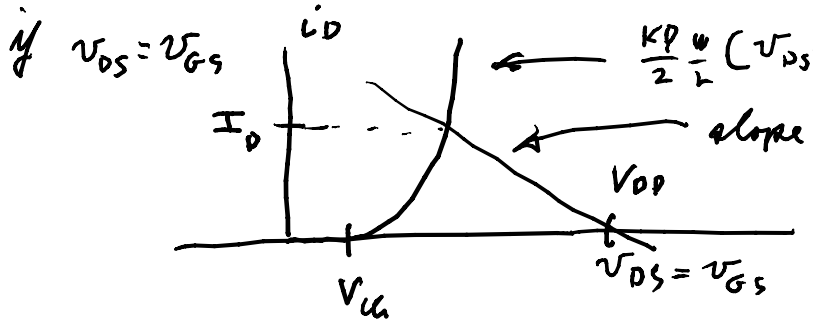


(a sink)

$i_{D_2} \approx i_{D_1}$ if $v_{DS_2} \approx v_{DS_1}$

we want a large enough v_{DS_2}

(no DC gate currents)



(see NA 741 op amp, p. 1003 for its BJT realization; many current mirrors, differential pairs & a power output).

Source current, use PMOS