6/9/19

Lec 18

NMOSFET

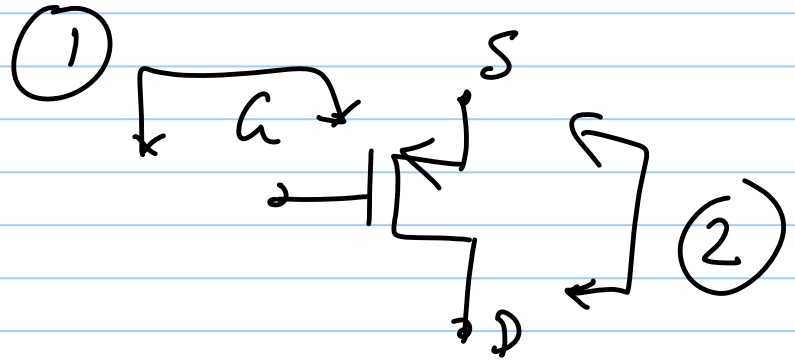
* I_D flows into (D)
* Sat : $V_D >> V_S$
* Tri limit : $V_D = V_G - V_{Tn}$
* $V_{GS} \geq V_{Tn}$ for $I_D \geq 0$
* $V_{Tn} > 0$ for enh. mode

PMOS transistor

* I_D flows out of (D)
* sat : $V_D << V_S$
* Tri limit : $V_D = V_G + V_{Tp}$
* $V_{SG} \geq V_{Tp}$ for $I_D \geq 0$
* $V_{Tp} > 0$ for enh. mode

$V_{Tn}, V_{Tp} > 0$: enhancement mode MOSFETs

$V_{Tn}, V_{Tp} < 0$: depletion mode MOSFETs



Small-signal :

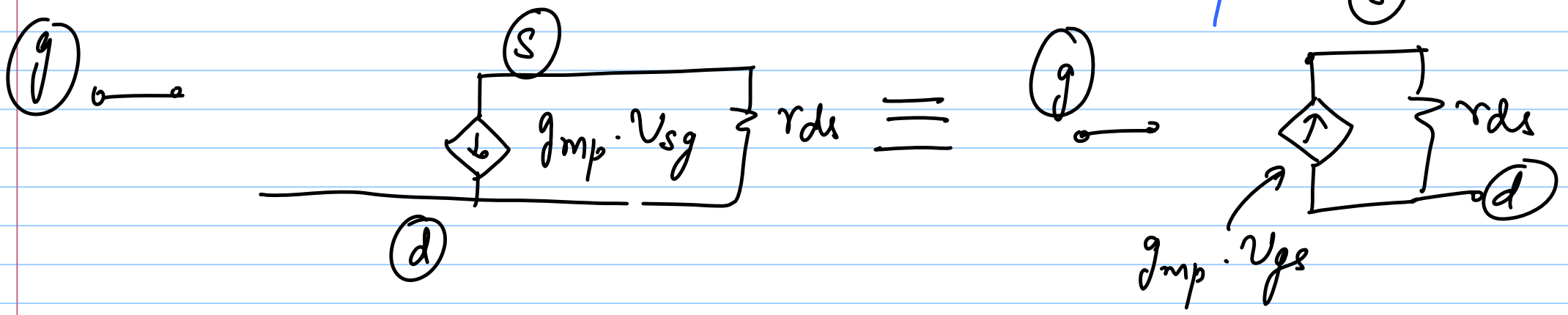
$$[y] = \begin{bmatrix} 0 & 0 \\ g_m & g_{ds_p} \end{bmatrix}$$

$$y_{21} = g_{m_p} = \mu_p C_{ox} \left(\frac{W}{L}\right)_p (V_{sg_p} - V_{T_p}) = \frac{\partial I_{SD}}{\partial V_{SG}} = \frac{\partial I_{D}}{\partial V_{G}}$$

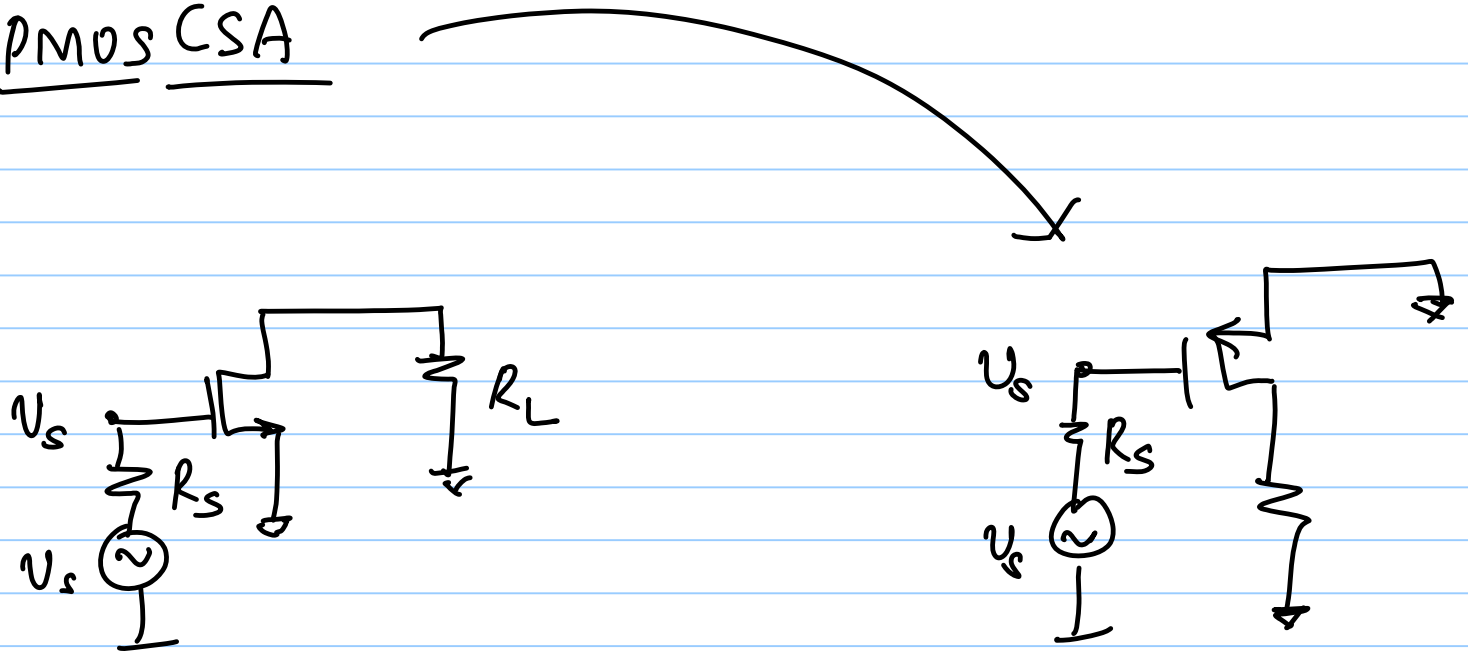
$$y_{22} = g_{ds_p} = \lambda_p I_D$$

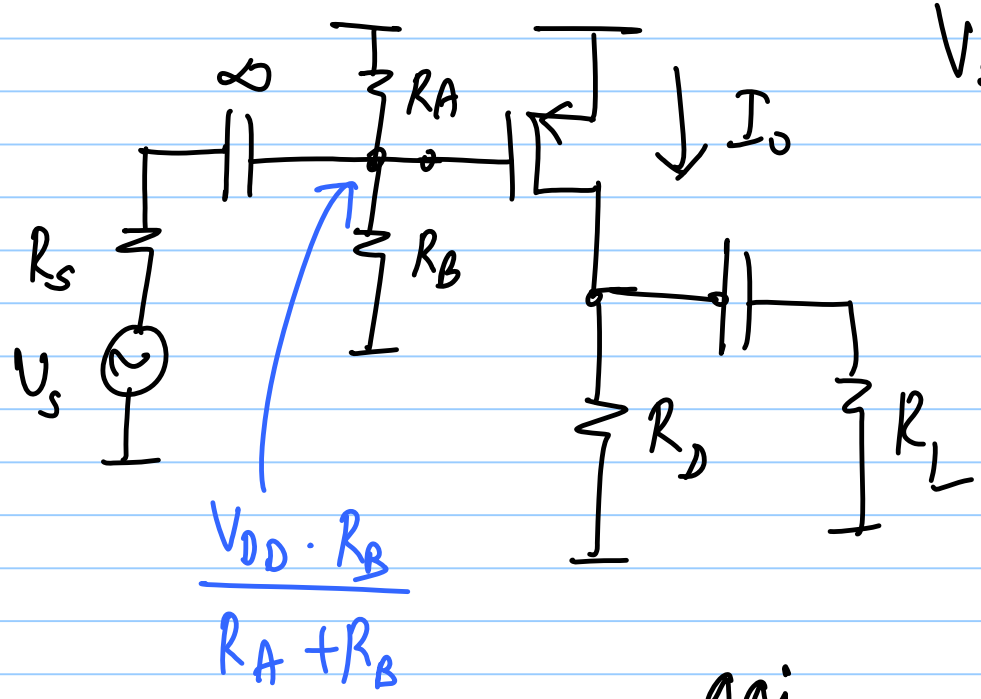
$$\text{intrinsic gain} = \frac{g_{mp}}{g_{ds_p}}$$

same as that for NMOS



PMOS CSA





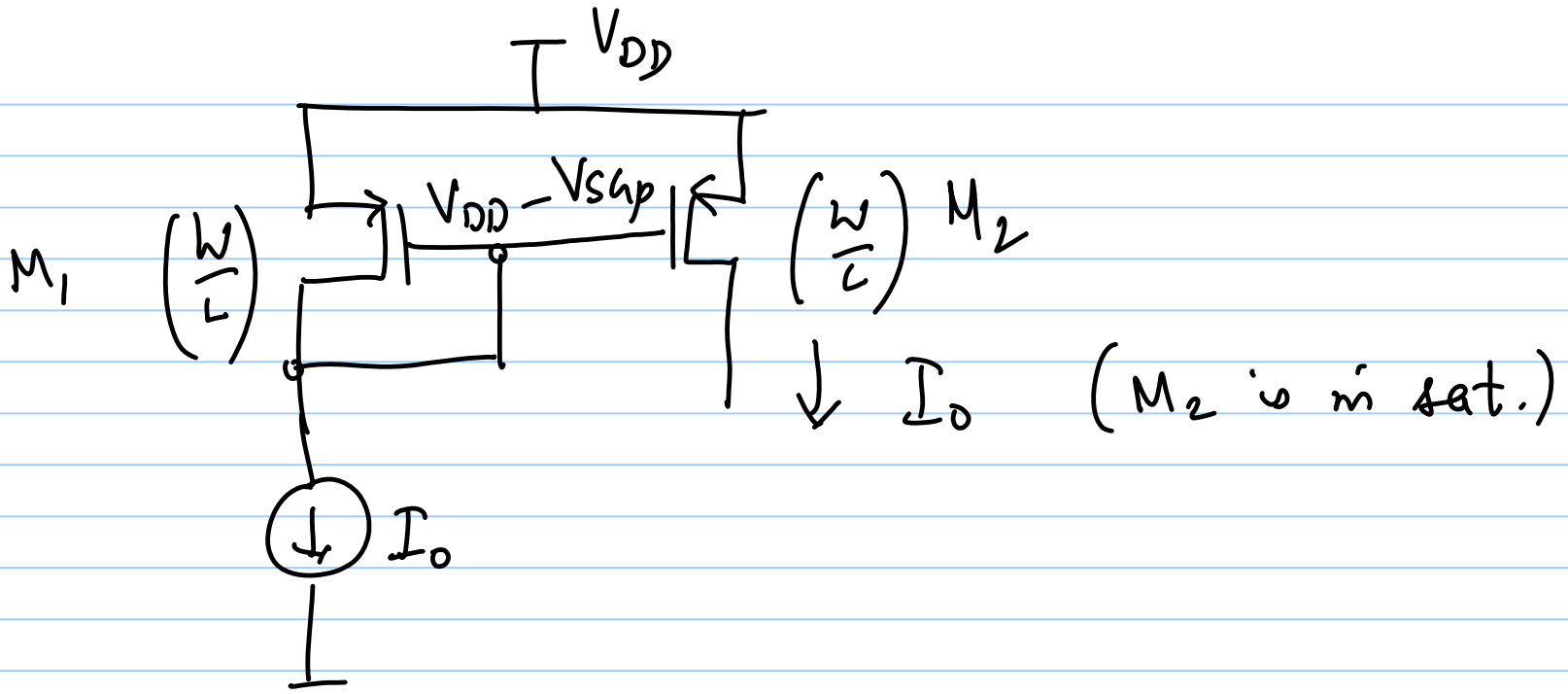
$$V_{sg} = \frac{V_{DD} \cdot R_A}{R_A + R_B} \Rightarrow I_0$$

$R_A \| R_B \Rightarrow \cdot R_s$

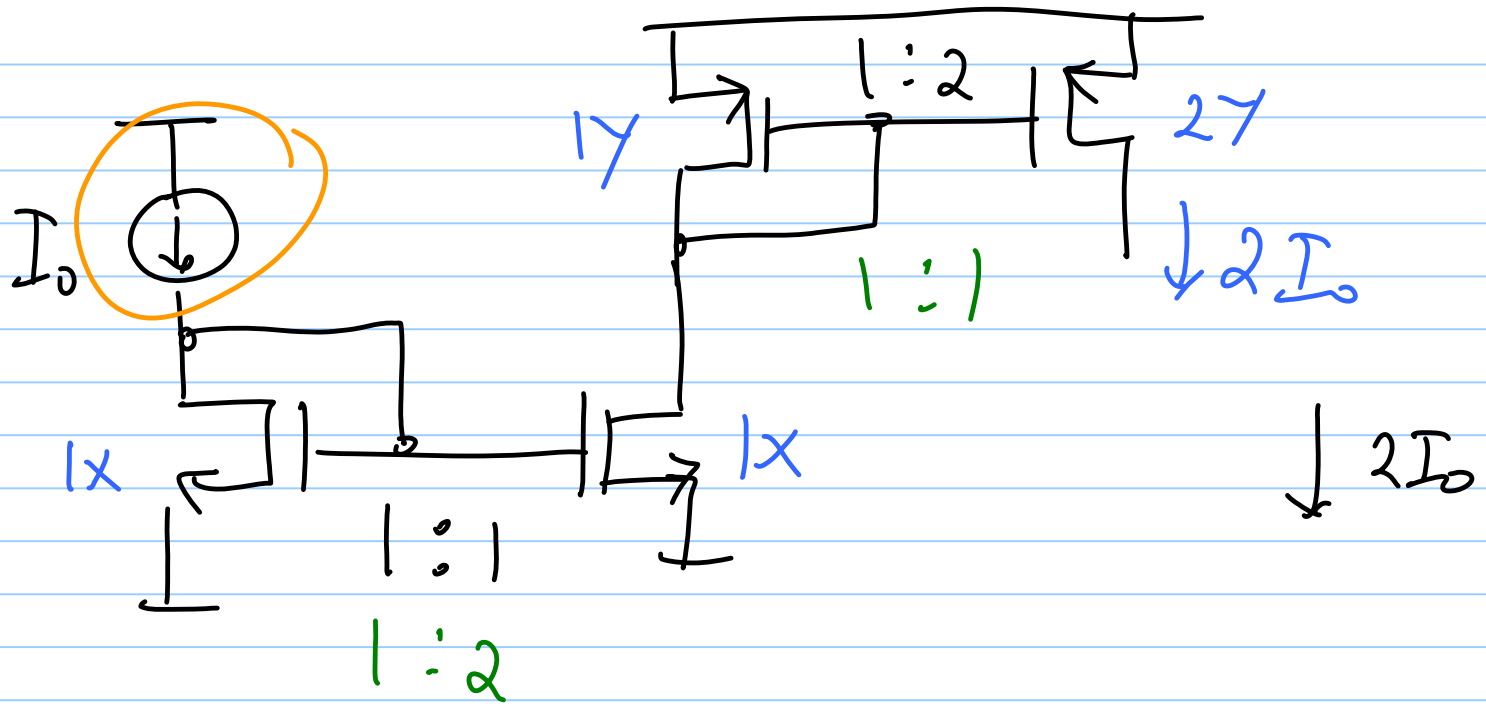
$$V_D = I_0 \cdot R_D$$

$$gain = -g_{m_p}(R_D \| R_L \| r_{ds_p})$$

HW: swing limits



(M_2 is in sat.)


I_0
1X
1:1
1:2
1Y
1:2
2Y
1:1
$2I_0$
$2I_0$