09/07/11

EE303

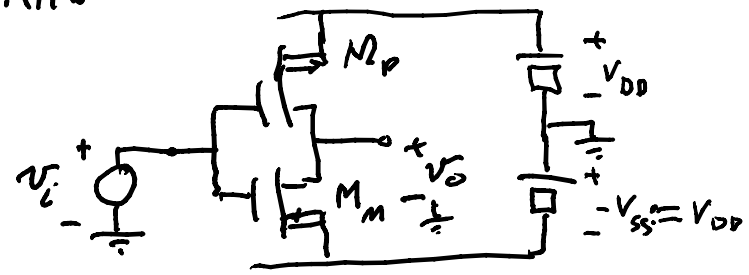
Note Title 3/7/2011

p. 1159 = pass transistor

p. 1359 = Schmitt triggers

p. 1119 = NAND

inverter



$$v_o = v_{DS_{M_n}} + V_{SS} \quad , \quad v_i = v_{GS_{M_n}} + V_{SS}$$

$$v_{DS_{M_n}} - v_{GS_{M_n}} = (v_o - V_{SS}) - (v_i - V_{SS}) = v_o - v_i$$

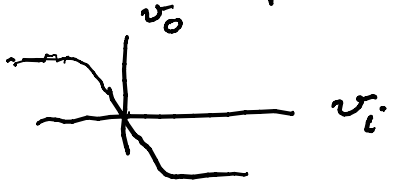
if bias so $v_o = v_i$ then $v_{DS} - v_{GS} = 0$

$\Rightarrow v_{DS} \geq v_{GS} - V_{TO_n}$

if enhancement mode

$V_{TO_M} > 0 \Rightarrow v_{DS} > v_{GS} - V_{TO_n} \Rightarrow M_n$ is in saturation

also M_p is in saturation



but $KP_p < KP_n$

so have to compensate by design of W_p

Here $i_{D_n} = i_{S_p} = -i_{D_p}$

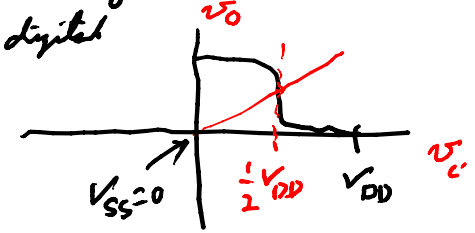
$$= \frac{KP_n}{2}\left(\frac{W}{L}\right)_n (v_{GS_n} - V_{TO_n})^2 (1 + \lambda_n v_{DS}) = \frac{KP_n}{2}\left(\frac{W}{L}\right)_n (-V_{SS} - V_{TO_n})^2 (1 + \lambda_n (-V_{SS}))$$

$$= \frac{KP_p}{2}\left(\frac{W}{L}\right)_p (v_{SG_p} - |V_{TO_p}|)^2 (1 + \lambda_p v_{SD}) = \frac{KP_p}{2}\left(\frac{W}{L}\right)_p (V_{DD} - |V_{TO_p}|)^2 (1 + \lambda_p V_{DD})$$

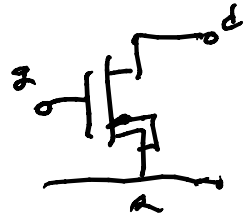
here solve for W_p if all else is known.

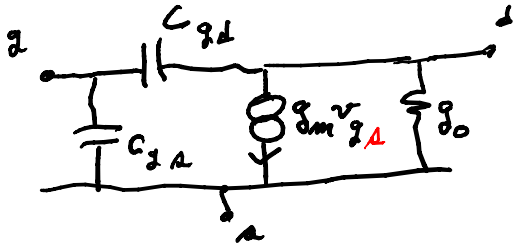
Gives zero out for zero in.

For digital



For MOS small signal:



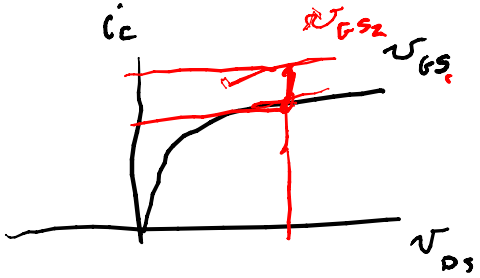


$$Y = \begin{bmatrix} s(C_{gs}+C_{gd}) & -sC_{gd} \\ g_m - sC_{gd} & sC_{gd}+g_o \end{bmatrix} ; \quad \begin{bmatrix} i_1 = i_g \\ i_2 = i_d \end{bmatrix} = Y \begin{bmatrix} v_{gs} \\ v_{ds} \end{bmatrix}$$

$$y_{11} = \left.\frac{i_1}{v_1}\right|_{v_2=0} = \text{short}$$

$$y_{21} = \left.\frac{i_2}{v_1}\right|_{v_2=0}$$

$$g_m = \left.\frac{\partial i_D}{\partial v_{GS}}\right|_{v_{DS}}$$

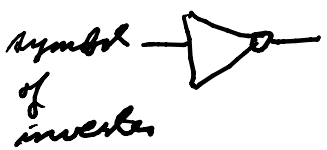


$$i_D = \frac{KP_n}{2}\left(\frac{W}{L}\right)(v_{GS}-V_{TO_n})^2(1+\lambda v_{DS})$$

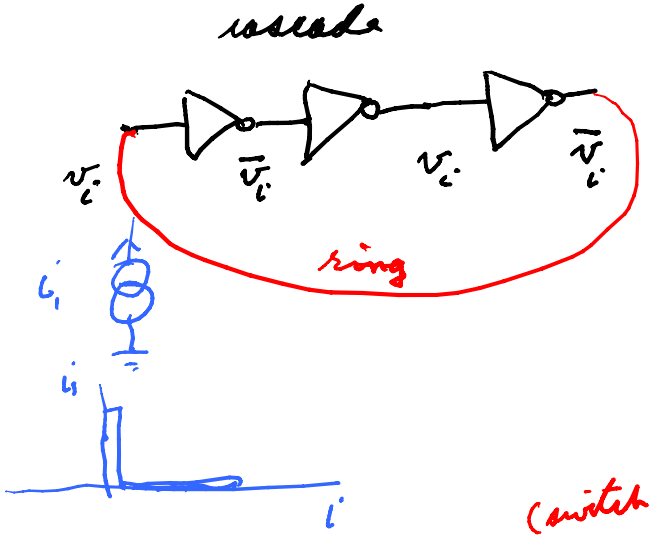
$$\frac{\partial i_D}{\partial v_{GS}} = 2\frac{KP_n}{2}\left(\frac{W}{L}\right)(V_{GS}-V_{TO_n})(1+\lambda V_{DS}) = \frac{I_D}{(V_{GS}-V_{TO_n})} = g_m$$

Ring oscillator

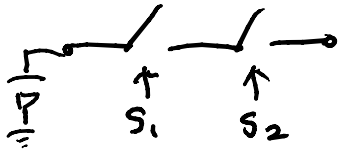
symbol of inverter

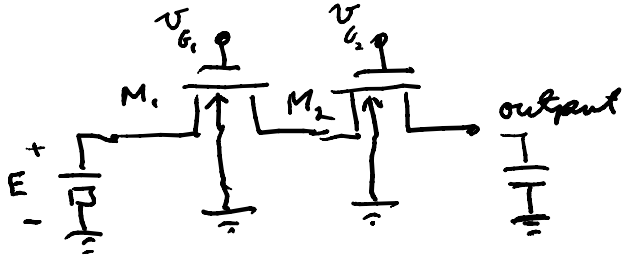


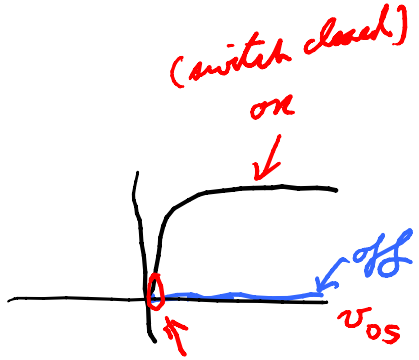
cascade



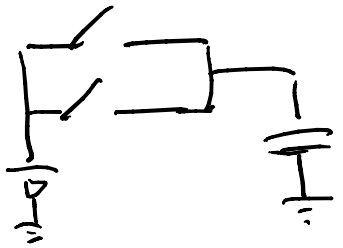
Pass transistors and







both M_1 & M_2 are on when $v_{G_1} = v_{G_2} = V_{DD}$



gives an or gate

improve a switch by putting N & P in parallel with complementary gate voltages.

Schmitt triggers.