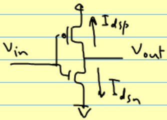
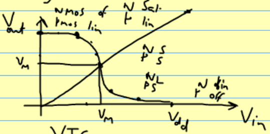
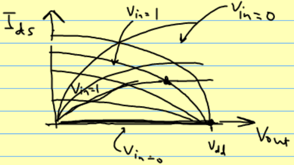
Inverter Analysis





VTC
(Voltage Transfer Curve)



V_M = switching threshold (trip point)

$V_{in} = V_{out}$

V_M

$$I_{ds_n} = -I_{ds_p}$$

$$k_n \left(V_M - V_{t_n} - \frac{V_{dsat\,n}}{2}\right) \cdot V_{dsat_n}$$

$\left(\mu C_{ox} \frac{W}{L}\right)_n$

$$= -k_p \left(V_M - V_{dd} - V_{t_p} - \frac{V_{dsat\,p}}{2}\right) \cdot V_{dsat_p}$$

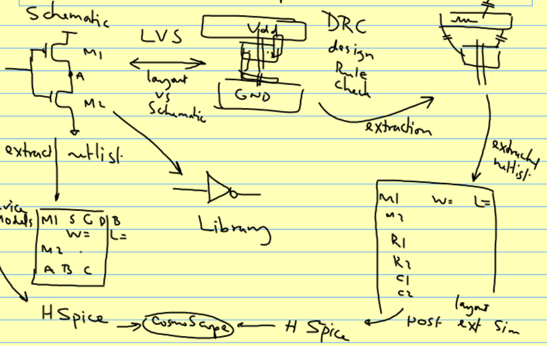
$$V_M - V_{t_n} - \frac{V_{dsat_n}}{2} = -\frac{k_p V_{dsat_p}}{K_n V_{dsat_n}} \cdot \left(V_M - \dots\right)$$

$= r$

$$\underline{\underline{V_M}} = \frac{V_{t_n} + \frac{V_{dsat_n}}{2} + r\left(V_{t_p} + \frac{V_{dsat_p}}{2} + V_{dd}\right)}{1+r}$$

$\underline{r \approx 1}$ and V_{dd} large $\Rightarrow$ $\underline{\underline{V_M}} \approx \frac{r}{1+r} V_{dd}$

[Design Steps]

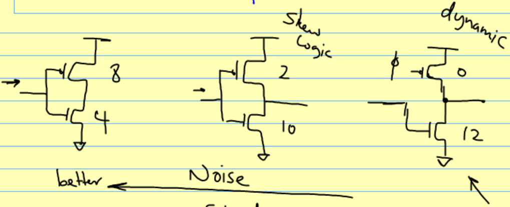


V_M and $r = 1$ (b/c want $V_M = \frac{1}{2} V_{dd}$)

$$r = \frac{k_p V_{dsat\,p}}{k_n V_{dsat\,n}} = \frac{(\mu C_{ox} \frac{W}{L})_p}{(\mu C_{ox} \frac{W}{L})_n} \cdot \frac{V_{dsat\,p}}{V_{dsat\,n}} = 1$$

$$\frac{W_p}{W_n} = \frac{\mu_n}{\mu_p} \cdot \frac{V_{dsat\,n}}{V_{dsat\,p}} \approx 2$$

NOISE vs Speed



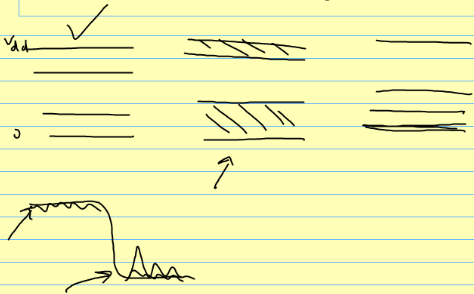
better ← Noise

Speed → better

better ← power

delay $\propto \frac{1}{w}$

NOISE Margin



Regenerative Property