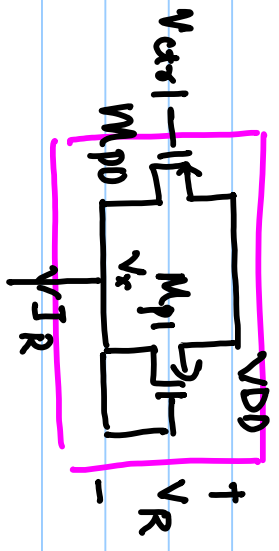
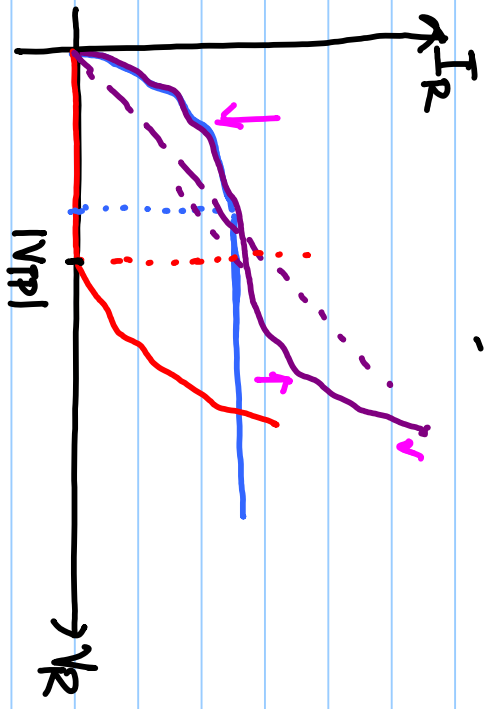
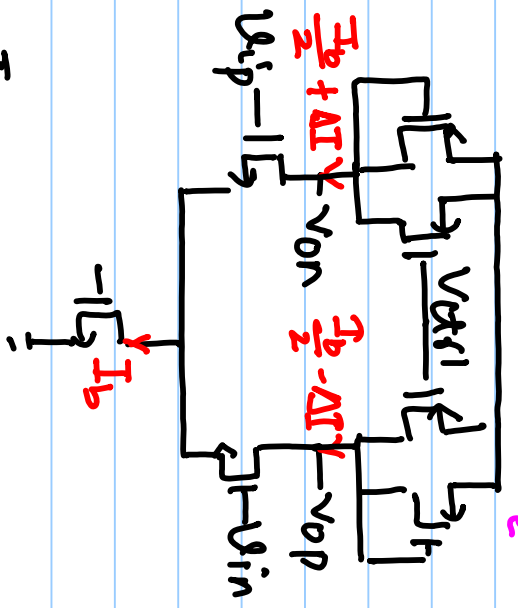


Lecture # 28



$M_{p1} : (V_{DD} - V_{x1}) - |V_{TP1}| > 0$

$V_R > |V_{TP1}|$

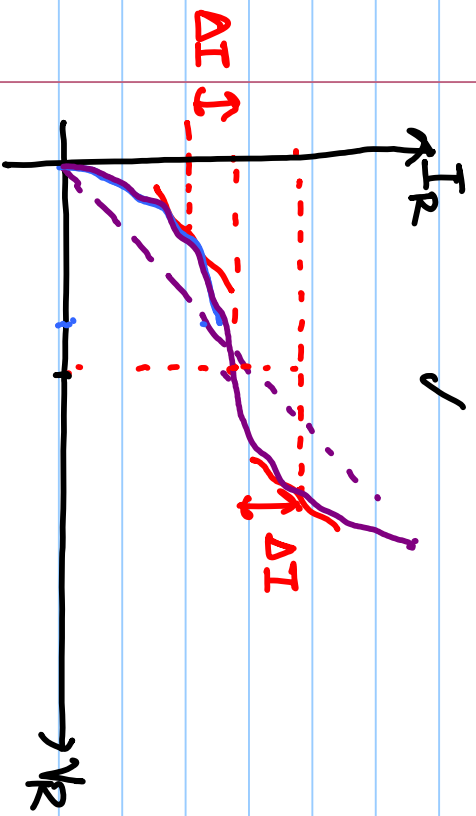
$M_{p0} : V_{DD} - V_{gs1} - |V_{TP1}| > \underbrace{V_{DD} - V_x}_{V_R}$

$V_R < (V_{DD} - V_{gs1} - |V_{TP1}|) \underbrace{V_R}_{\text{linear}}$

$V_R > V_{DD} - V_{gs1} - |V_{TP1}| \text{ sat.}$

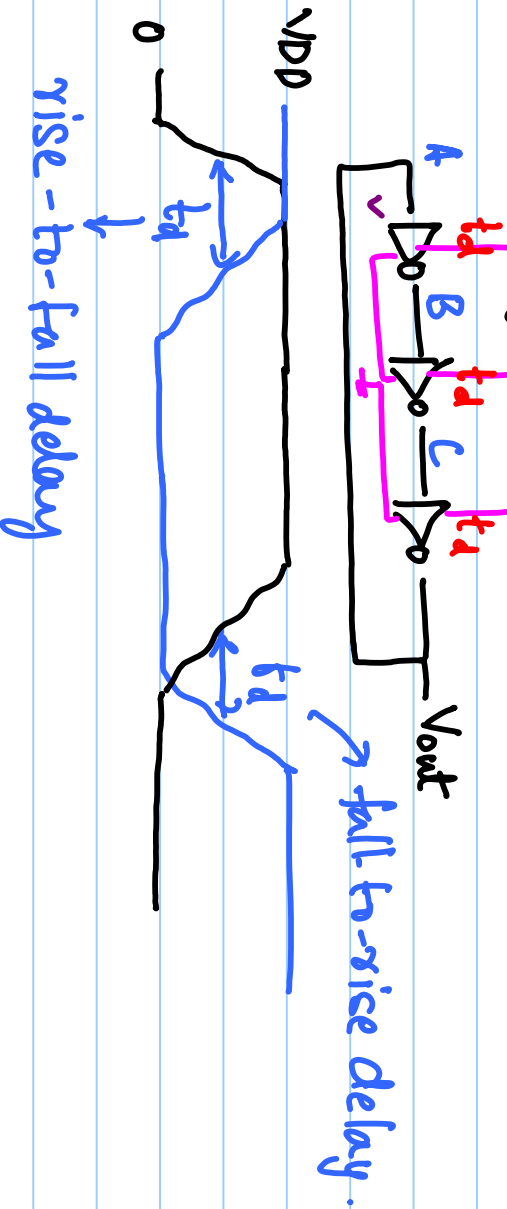
$V_{op} = V_{DD} - \left(\frac{I_p}{2} - \Delta I\right) R (I_p, V_R)$

$V_{on} = V_{DD} - \left(\frac{I_p}{2} + \Delta I\right) R (I_p, V_R)$



$$R_V = \frac{dV_R}{dI_R}$$

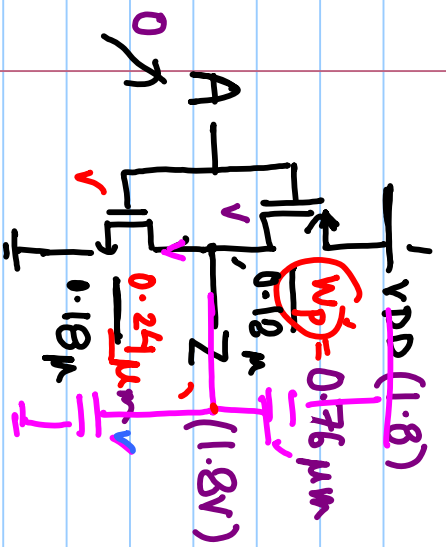
Large-swinging oscillators.



$$T = 6 t_d$$

$$t_d \rightarrow T$$

$$f_{osc} (1/T) \rightarrow t_d$$



16THz \rightarrow 1ns.

$$t_{rise} = t_{fall} = 12-16\% \times T$$

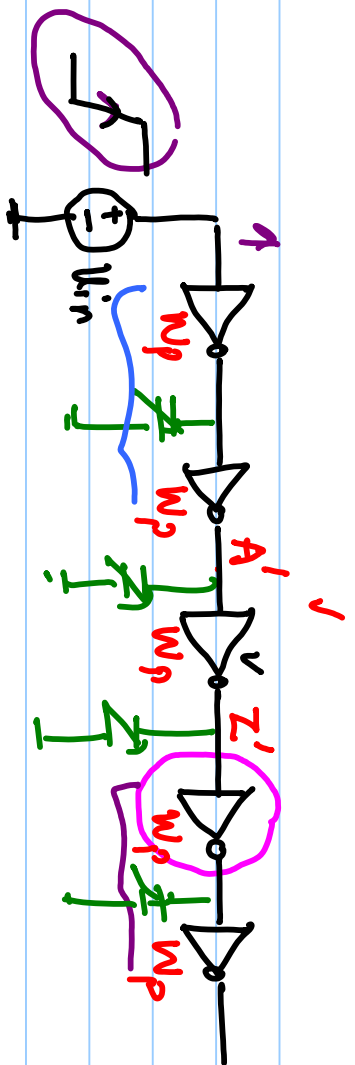


$$t_{dff} \leq t_{dff} = t_d = 50ps.$$

NMOS: $V_{DS} = V_{DD}$

Starts in saturation region

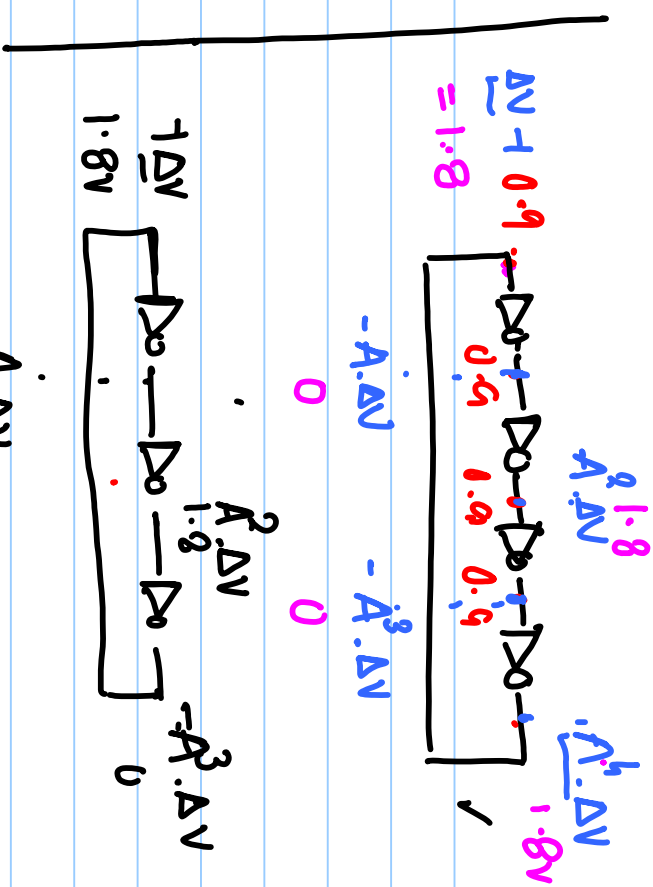
$$V_G - 0 - V_{tn} = \text{gate overdrive}$$



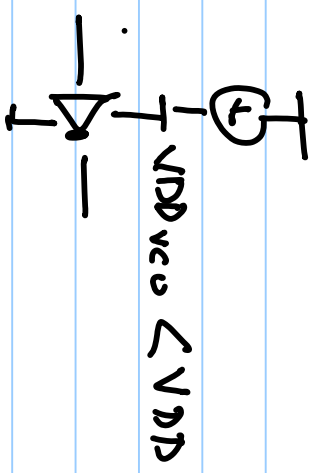
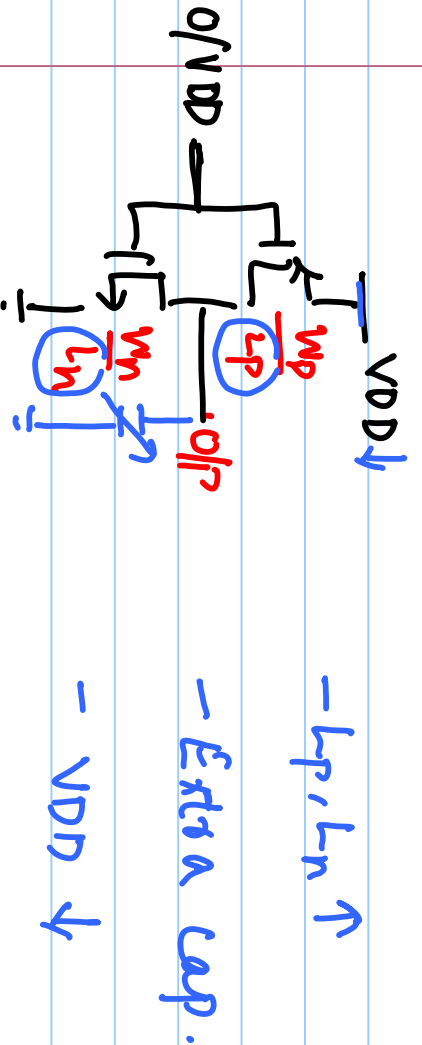
$$V_T = 2 \times N \times t_d$$

$$1 \text{ ns} = 2 \times N \times 50 \text{ ps}$$

$$N = \frac{1500}{100} = 15$$



$$t_d = \frac{1 \text{ ns}}{6} = \frac{1500}{6} = 166.67 \text{ ps}$$



~~Wp~~ ~~Lp~~ ~~Wn~~ ~~Ln~~
 Current-starved
 inverters.

