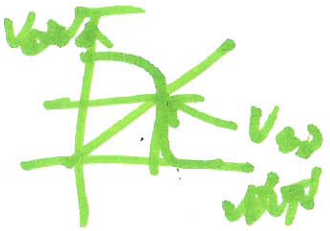
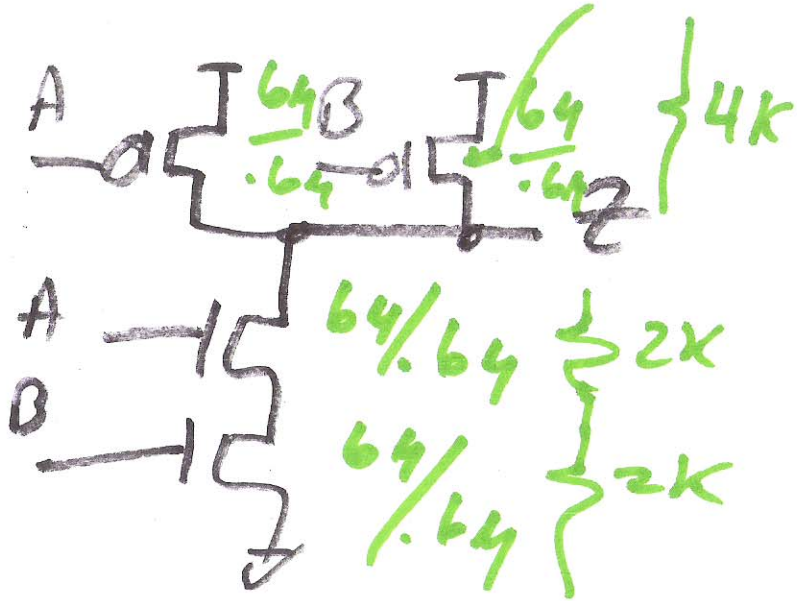
Lecture 24

11/21/14

Static logic gates



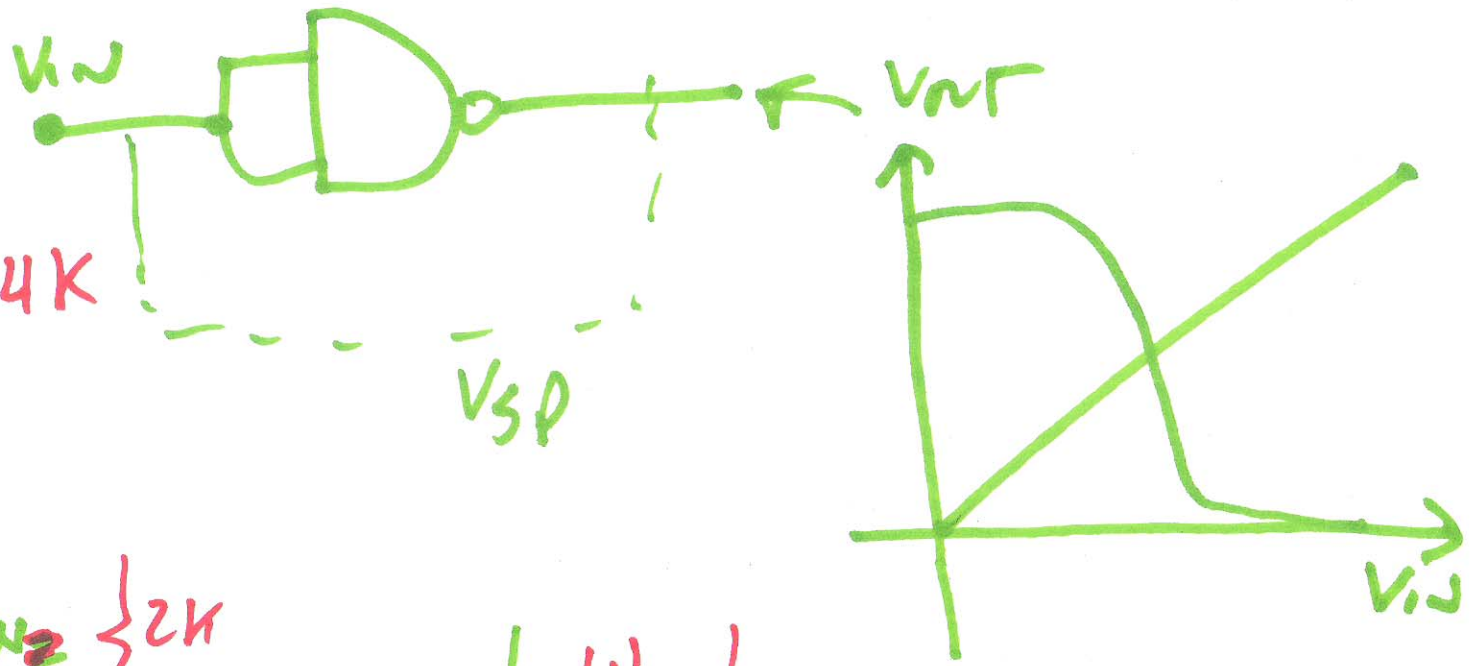
A	B	Z
0	0	1
0	1	1
1	0	1
1	1	0

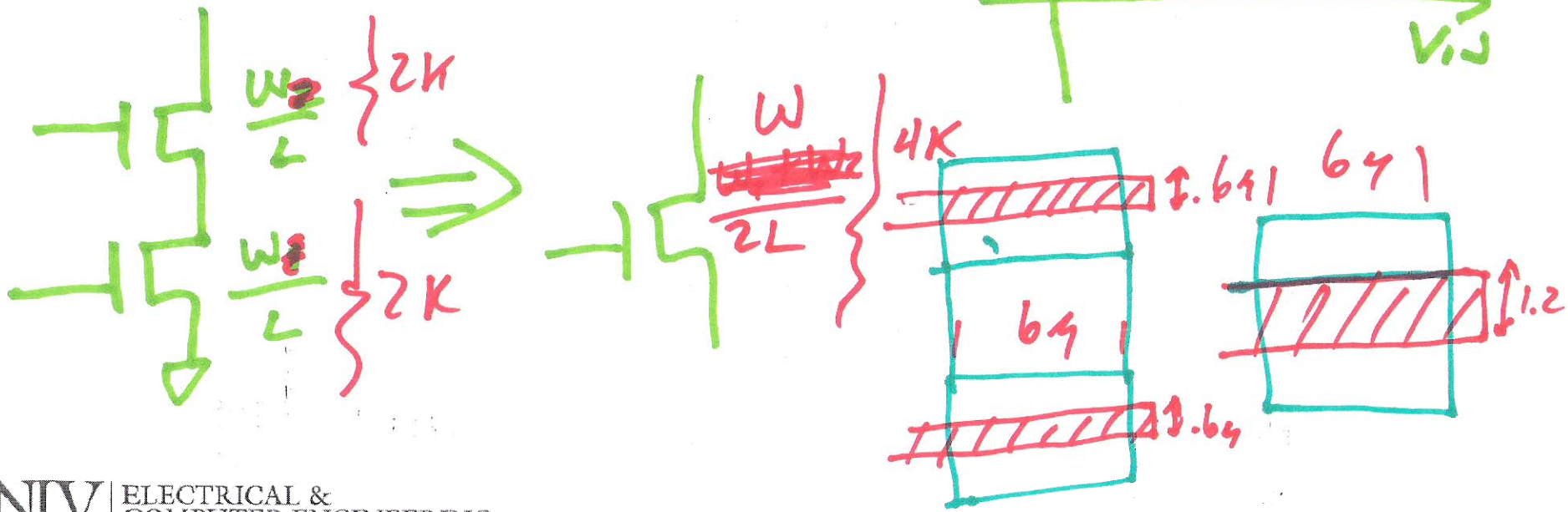


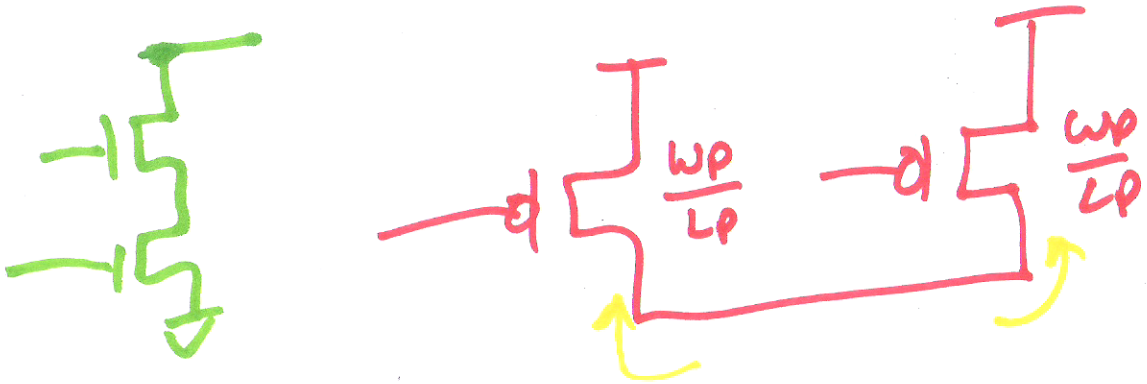
Switching point Voltage

$\frac{L}{W_1+W_2} \cdot \beta'$

$\frac{1.2}{64} \cdot 20K \cdot \frac{\text{[illegible]}}{\text{[illegible]}} = 4K$







$$\beta = K_P \cdot \frac{W}{L} \quad \begin{matrix} 10 \\ .6 \end{matrix}$$

$$\beta_P \cdot 2 = \beta_N$$

$$K_{P_P} = \mu_P \cdot C_{ox}'$$

$$K_{P_N} = \mu_n \cdot C_{ox}'$$

$\frac{2W_P}{L}$

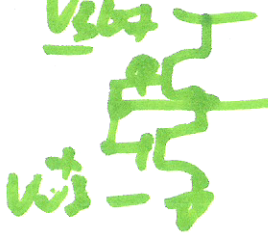
$$K_P' \cdot \frac{L}{2W} = 40k \cdot \frac{.6}{.24}$$

$$= 2k$$

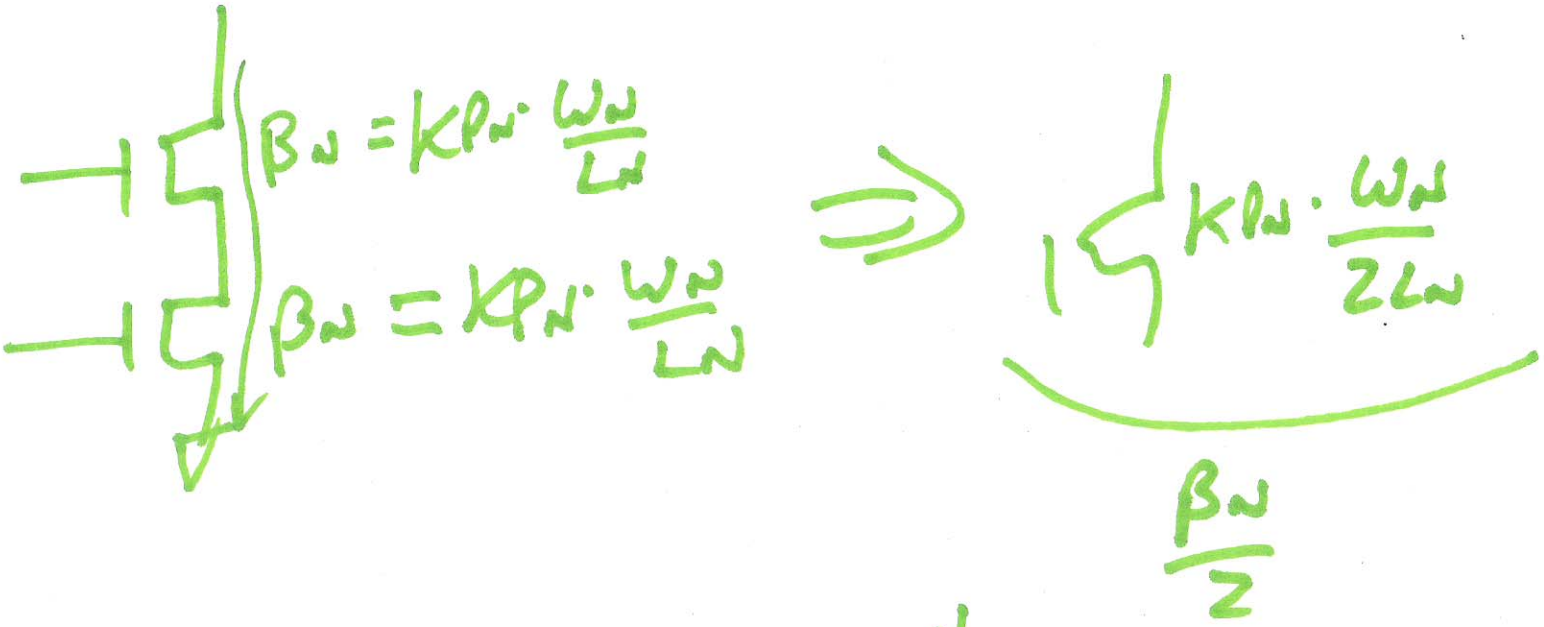
$$K_P \cdot 2 = K_{P_N}$$

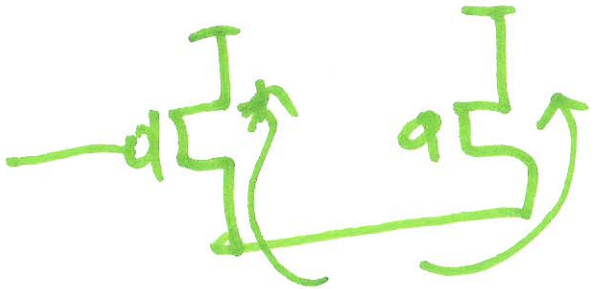
$$V_{SP} = \frac{\sqrt{\frac{\beta_N}{N2 \cdot \beta_P}} \cdot V_{TN} + (VDD - |V_{THP}|)}{1 + \sqrt{\frac{\beta_N}{N2 \cdot \beta_P}}}$$

$2\beta_{P1}$ $\quad \frac{\beta_N}{2}$



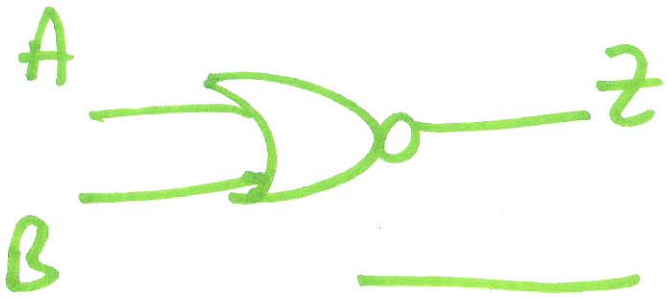
$$VDD - V_{SG} - V_{DS} = 0$$





$$K_{PP} = 2\frac{W_P}{L_P}$$

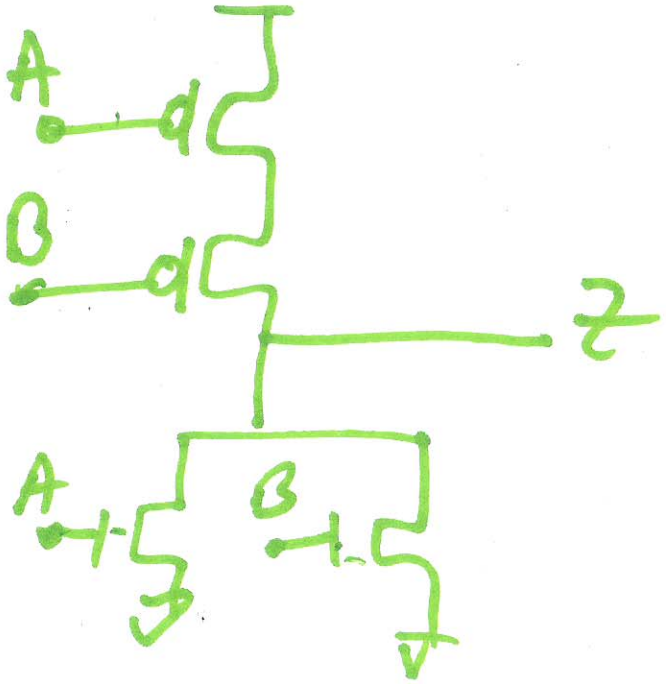
$$I_D = \frac{\beta}{2}\left(V_{bs} - V_{THN}\right)^2 \Rightarrow V_{bs} = \sqrt{\frac{2I_D}{\beta}} + V_{THN}$$

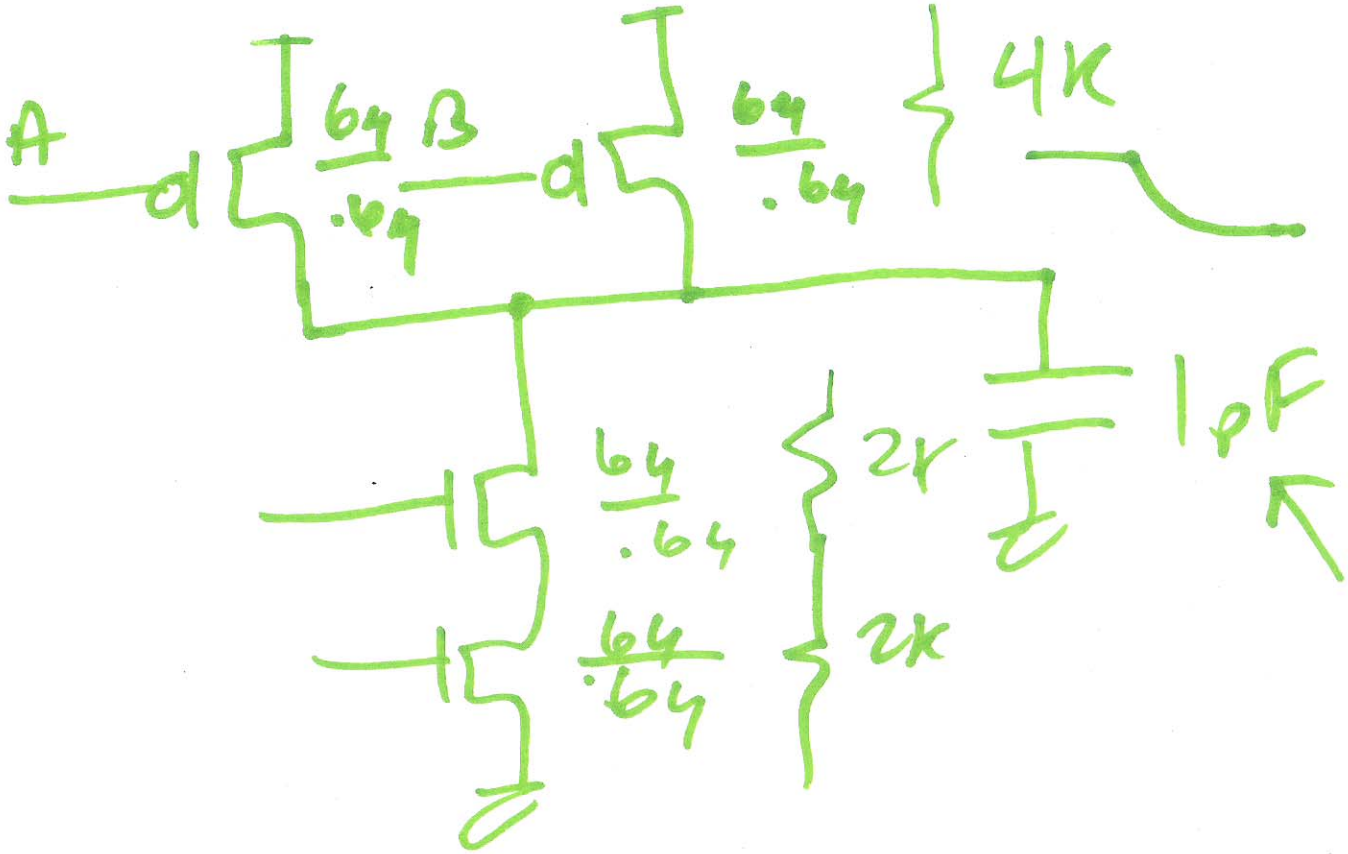


A	B	Z
0	0	1
0	1	0
1	0	0
1	1	0

$$Z = \overline{A + B}$$

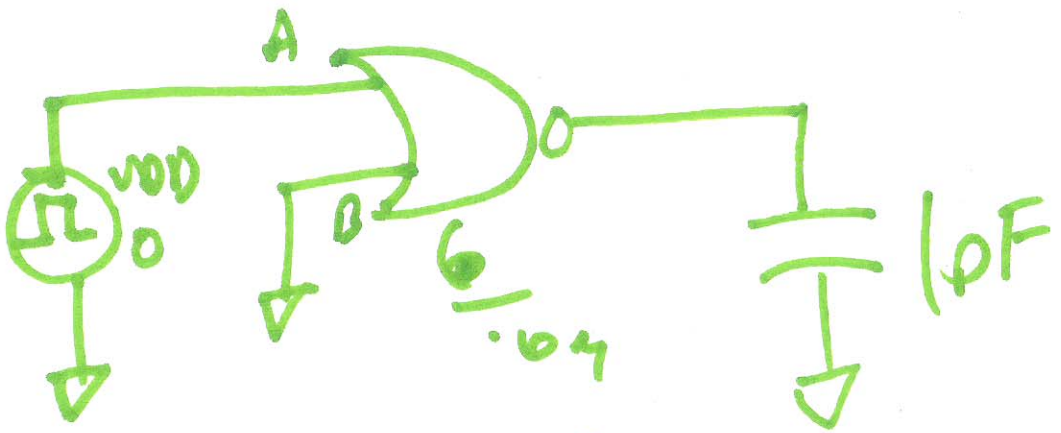
$$= \bar{A}\,\bar{B}$$



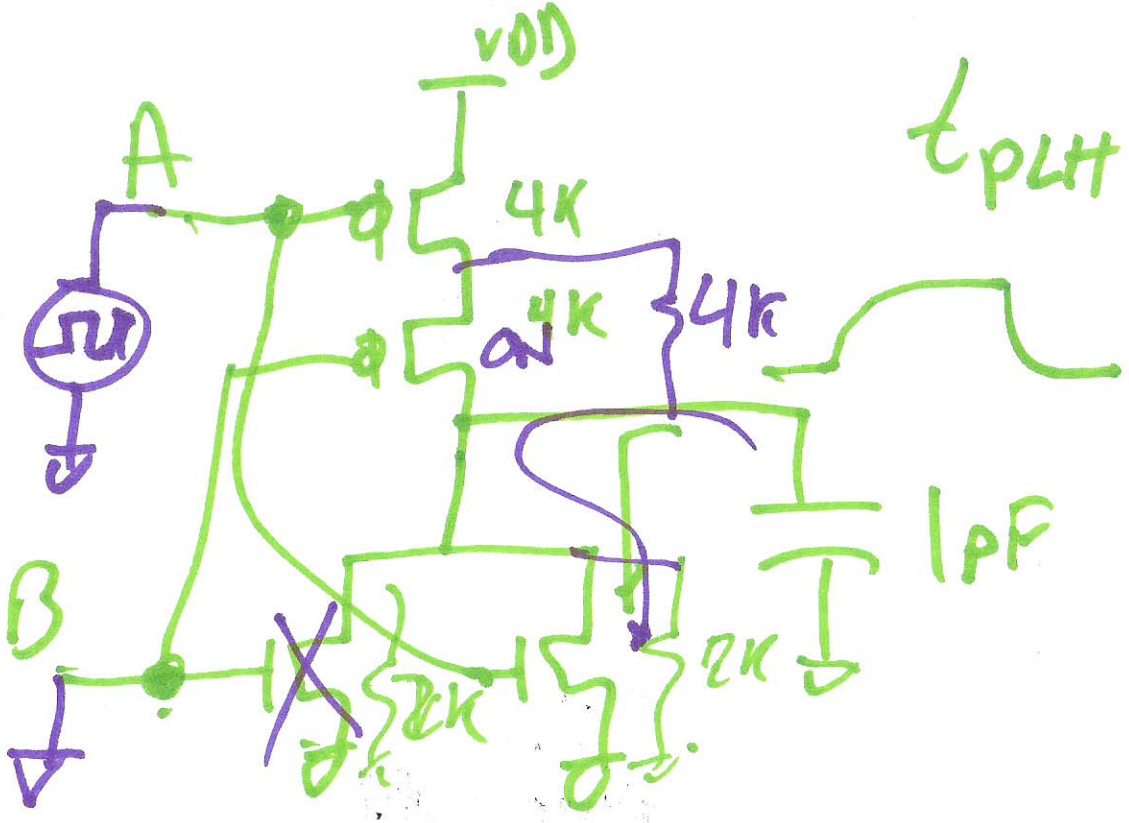


$$t_{pHL} = 0.7(4k)\,1pF = \underline{2.8ns}$$

$$t_{pLH} = 0.7(4k)\,1pF = \underline{2.8ns}$$

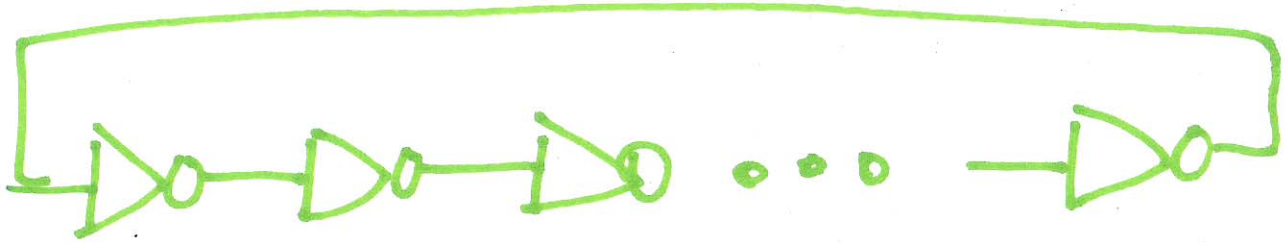


t_{pHL} & t_{pLH}



$t_{pLH} = 0.7 \cdot 2 \cdot 4k \cdot 1pF$

$t_{pHL} = 0.7 \cdot \frac{4}{2} \cdot 2k \cdot 1pF$



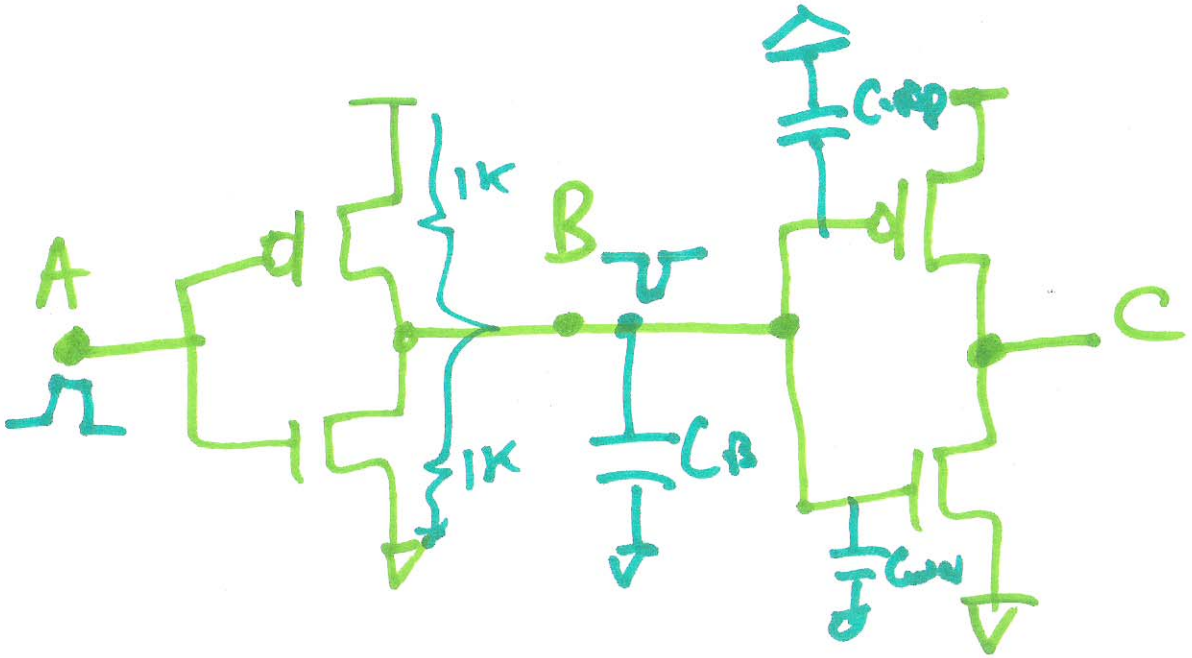
N-Stage ring oscillator

NMOS → $\frac{12\lambda}{.6\lambda}$ PMOS → $\frac{24\lambda}{.6\lambda}$

If N = 51 what is f_{osc}?

What is the delay of an INVERTER?

t_{PHL} t_{PLH}



$R_N' = 20K, R_P' = 40K$

$C_{ox}' = 2.5\,fF/\mu m^2$

$R_N = \frac{0.6}{12} \cdot 20K = \underline{1K}$

$R_P = \frac{0.6}{24} \cdot 40K = \underline{1K}$

$C_{oxN} = 2.5fF \cdot (0.6)(12) = 18fF$

$C_{oxP} = 2.5fF(0.6)(24) = 36fF$

$t_{pHL} = 0.7 \cdot 1K \cdot 135fF$

$t_{pLH} = t_{pHL}$

$= \underline{94.5ps}$

$C_B = C_{INN} + C_{INP} + C_{oxN} + C_{oxP} +$ ~~[illegible]~~

$= \underbrace{\frac{3}{2}18}_{27} + \underbrace{\frac{3}{2}36}_{54} + 18 + 36 = \underline{135fF}$

$f_{osc} = \frac{1}{51(94.5+94.5)} = \underline{104MHz}$