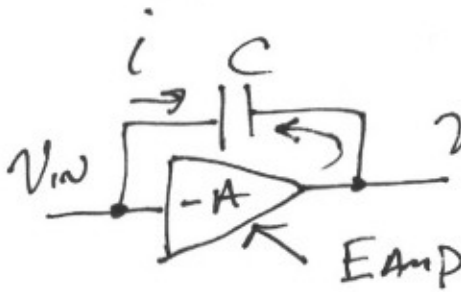
ECE 5/410 Physical IC Design

BOISE STATE UNIVERSITY

4/2/09 Lecture 19



$V_{OUT} = -A \cdot V_{in}$

V_{OUT} 0 V_{IN} 0 -10

$A = 10$

$C = 1pF$

$V_{IN} = 1$

$f = 10^6$

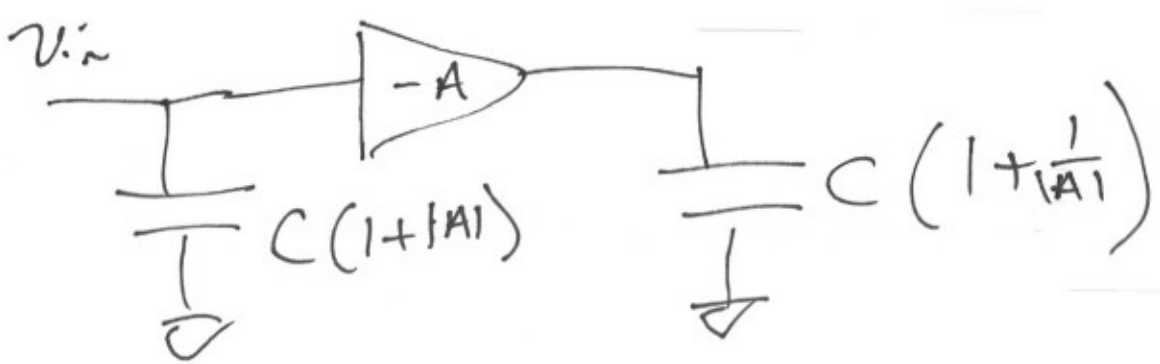
$$i = \frac{V_{in} - (-A \cdot V_{IN})}{1/j\omega C} = j\omega C\left(1+|A|\right)V_{in}$$

$$|0| = 2\pi \cdot 10^6 \cdot 10^{-12} \cdot 11 \cdot 1$$

$$i = \frac{V_{OUT} - V_{in}}{1/j\omega C} \quad \left(V_{in} = \frac{-V_{OUT}}{|A|}\right) = V_{OUT}\left(1+\frac{1}{A}\right) \cdot j\omega C$$

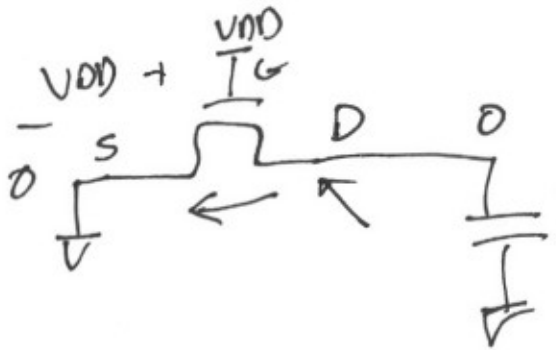
$$= 6.28 \cdot 10^{-6} \cdot 11$$

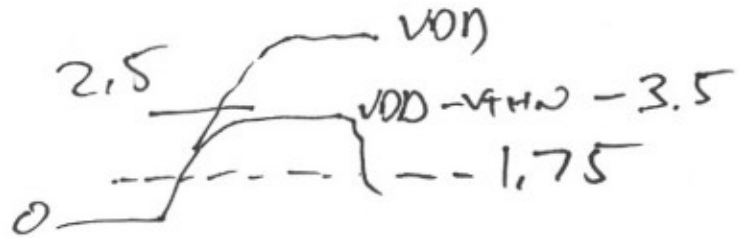
$$\approx 69.14\,\mu A$$

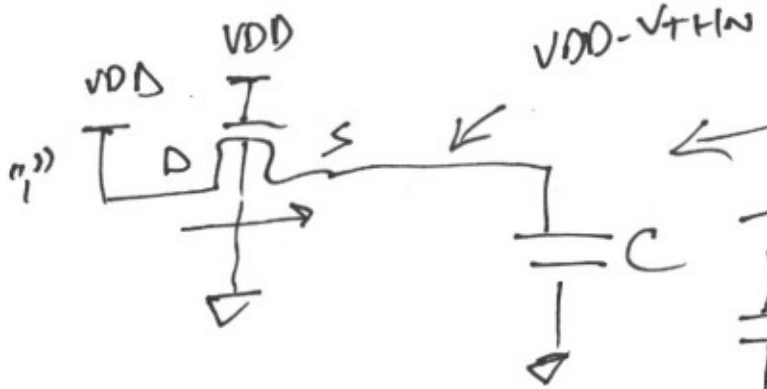


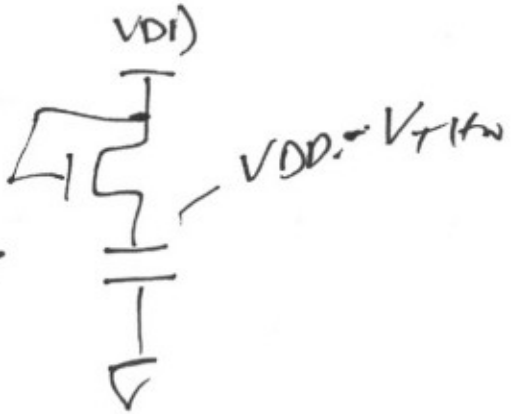
1)

Pass Gates

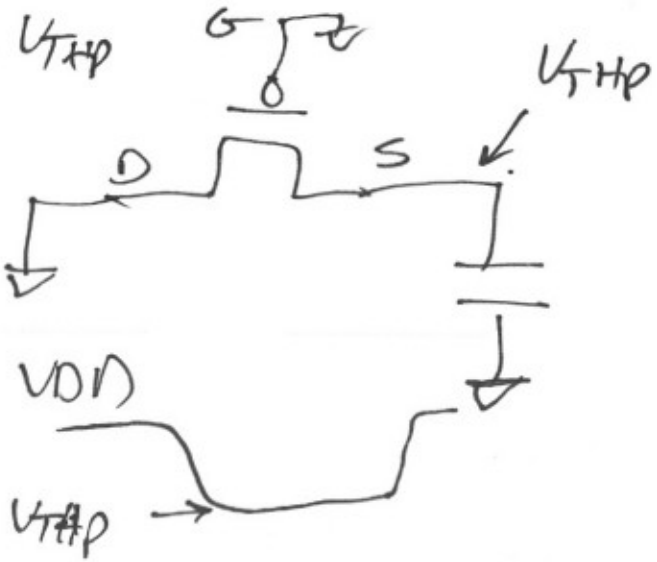

VDD
VDD +
G
S
D
0
0

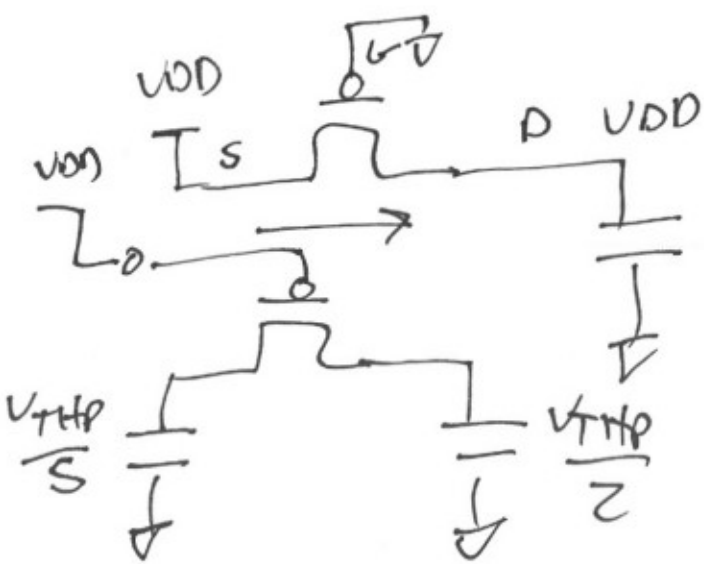

VDD
2.5
VDD-VTHN - 3.5
1.75
0


VDD
VDD
VDD-VTHN
"1"
D
S
C

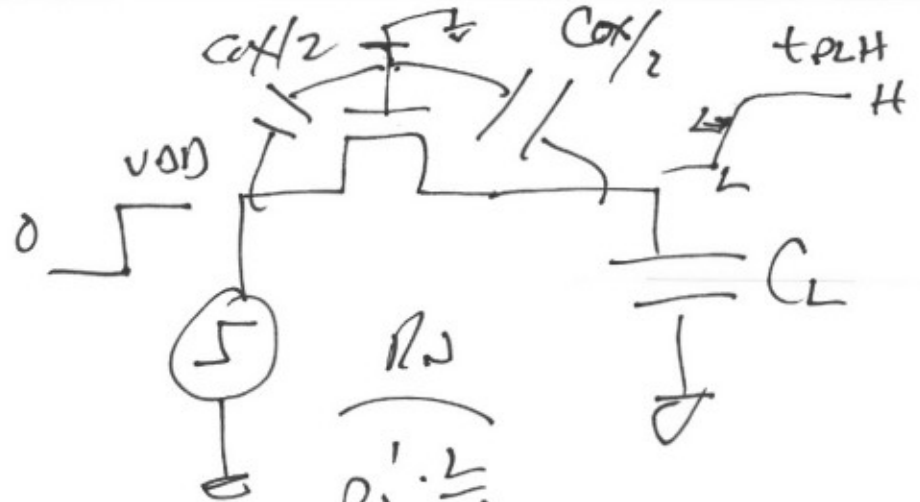

VDD
VDD-VTHN


VTHP
d

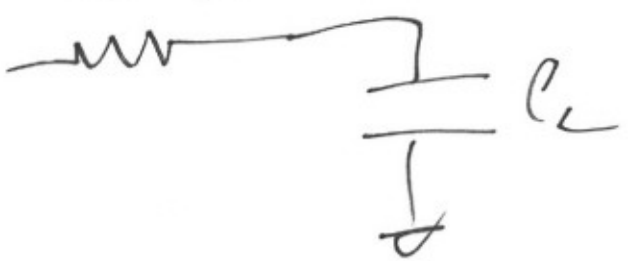

G
VTHP
D
S
VDD
VTAP


VDD
G
VDD
S
D VDD
0
VTHP
S
VTHP
2

2)

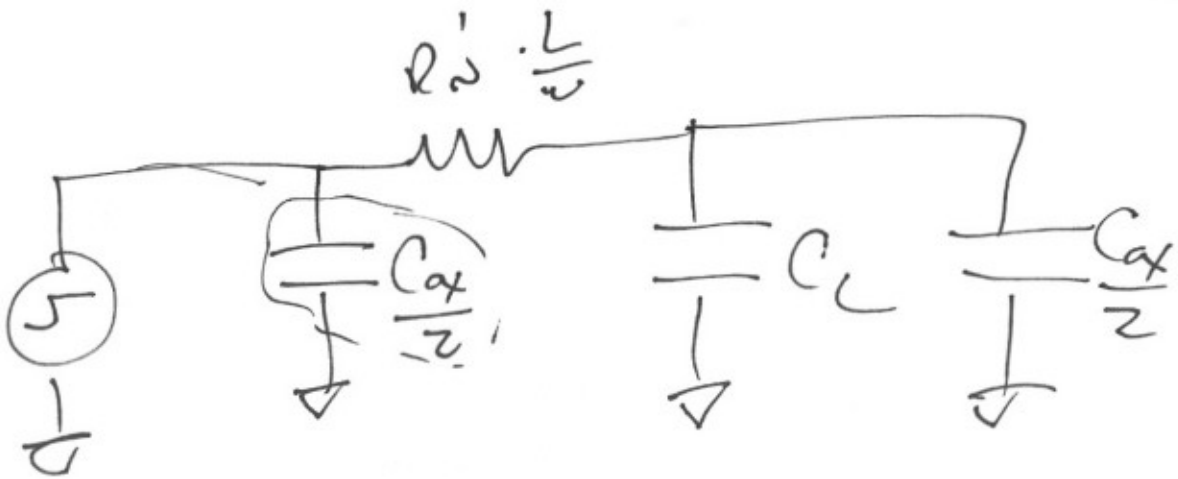


C_L is big



$t_{pLH} \approx 0.7 R_N C_L$

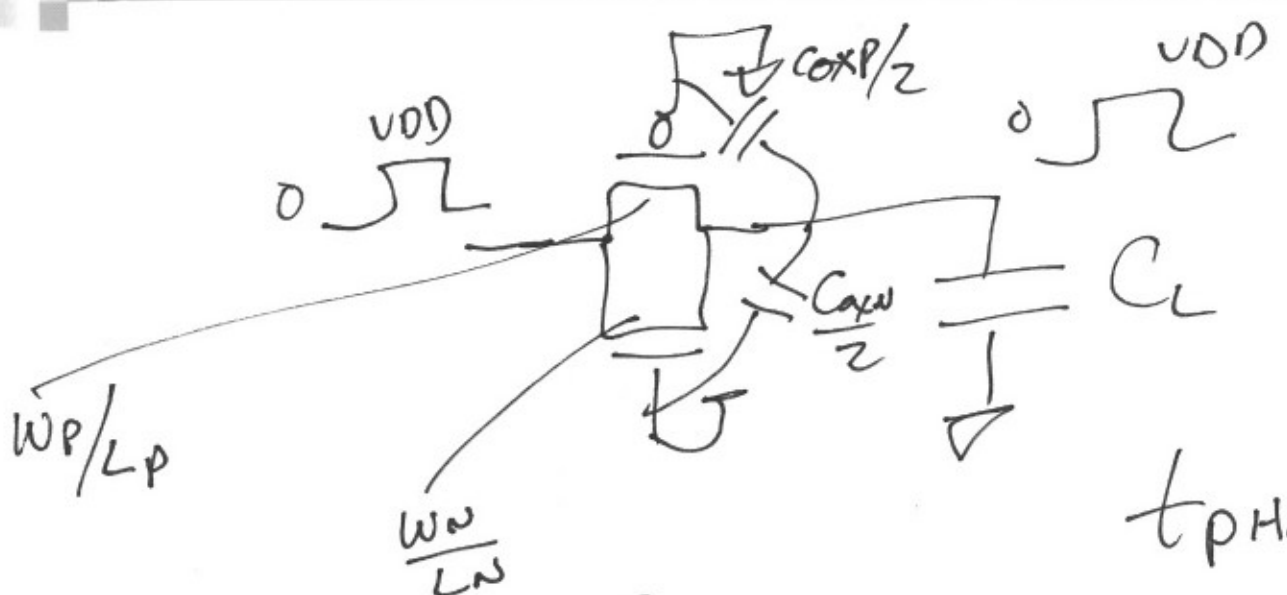
C_L is small



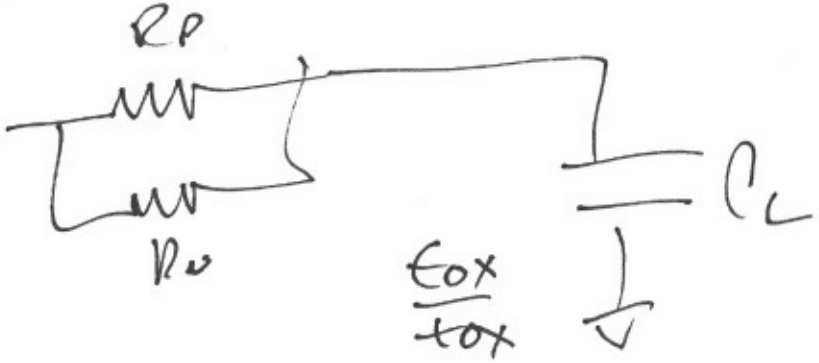
$t_{pLH} \approx 0.7 R_N \left(C_L + \frac{C_{ox}}{2}\right)$

3)

transmission Gate (TG)



$$t_{pHL} = t_{pLH} =$$



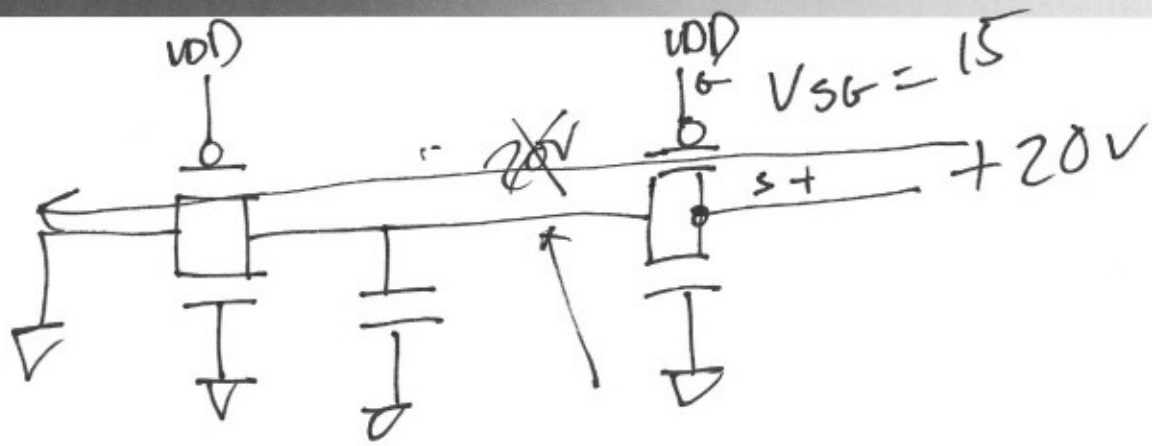
$$0.7\,(R_N \| R_P) \cdot \left(C_L + \frac{C_{oxp}}{2} + \frac{C_{oxN}}{2}\right)$$

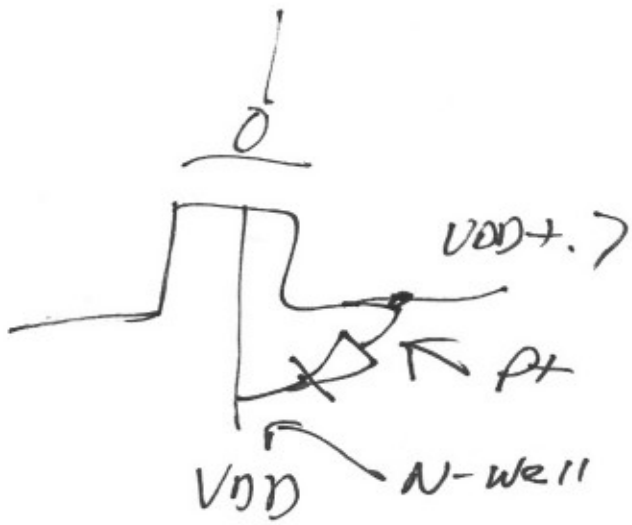
$$C_{oxp} = C'_{ox} \cdot W_p L_p$$

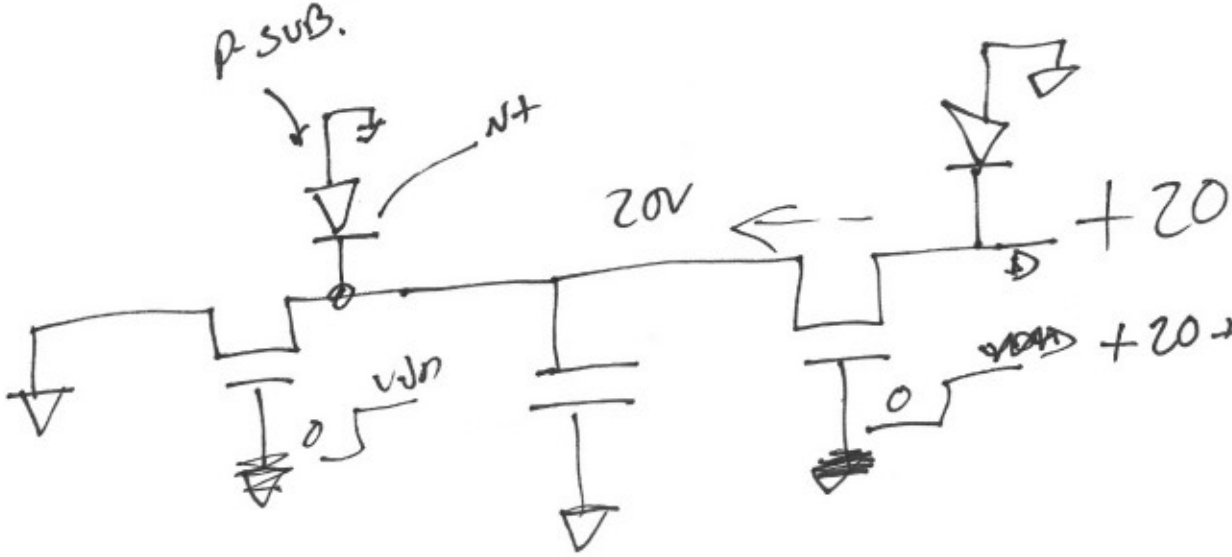
$$C_{oxN} = C'_{ox} \cdot W_N L_N$$

4)

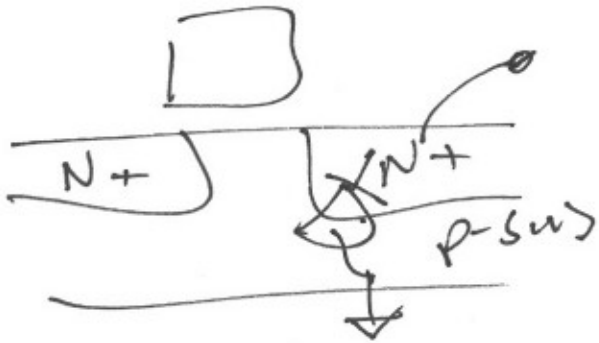
VDD = 5V

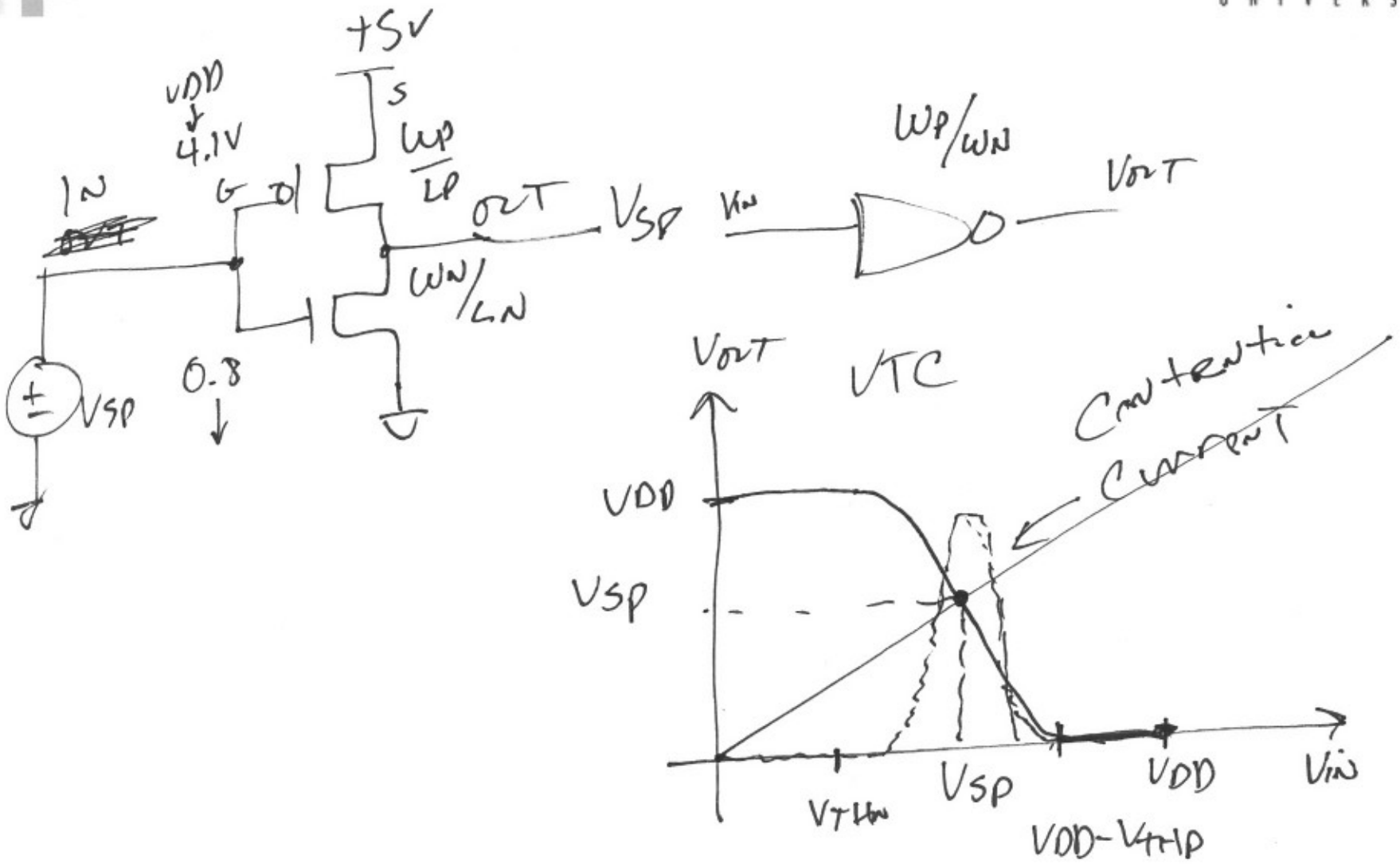

VDD
VDD
VSG = 15
+20V
S+


VDD+.7
P+
VDD
N-well

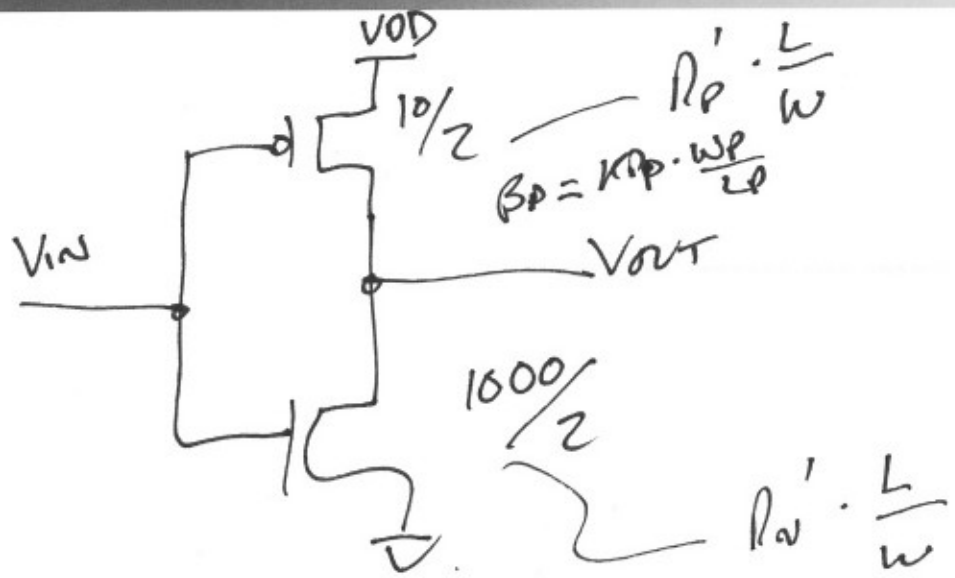

P SUB.
N+
20V
+20
VDD
VDD
+20 + V+HN!

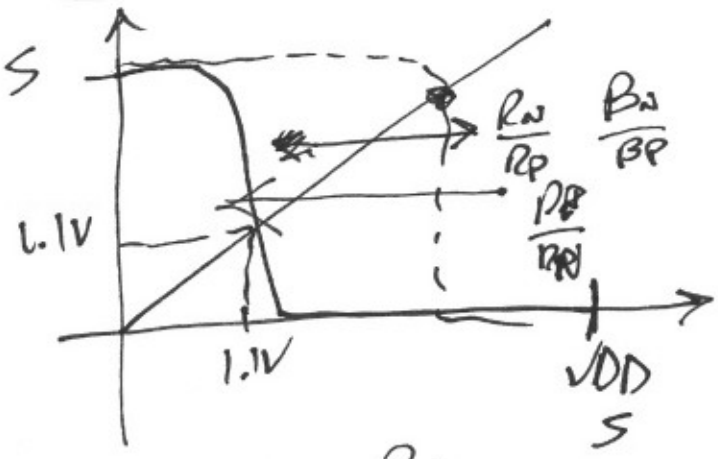
5)


N+
N+
P-SUB

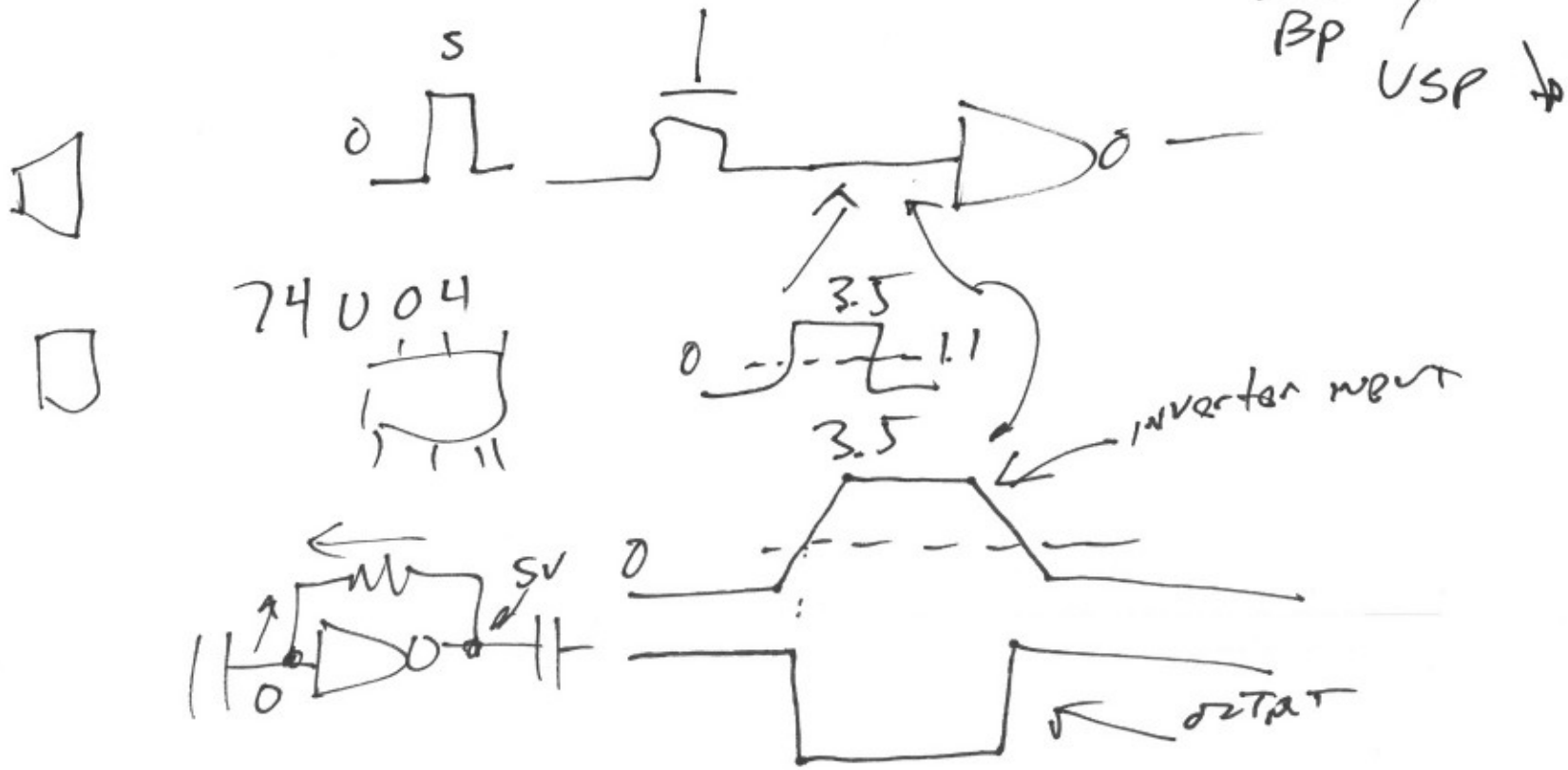

+5V
VDD
4.1V
S
WP
LP
IN
G
D
OUT
VSP
WN/LN
0.8
VSP
WP/WN
IN
VOUT
VOUT
VTC
Contention
Current
VDD
VSP
VTHN
VSP
VDD
VIN
VDD-VTHP

6)

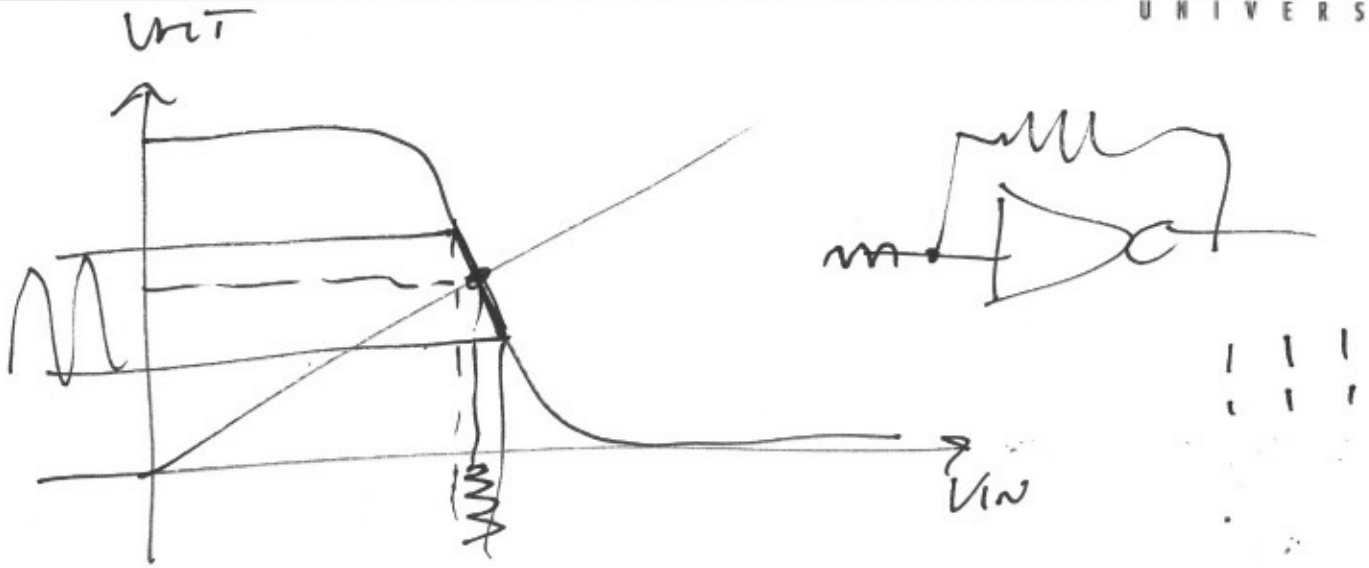




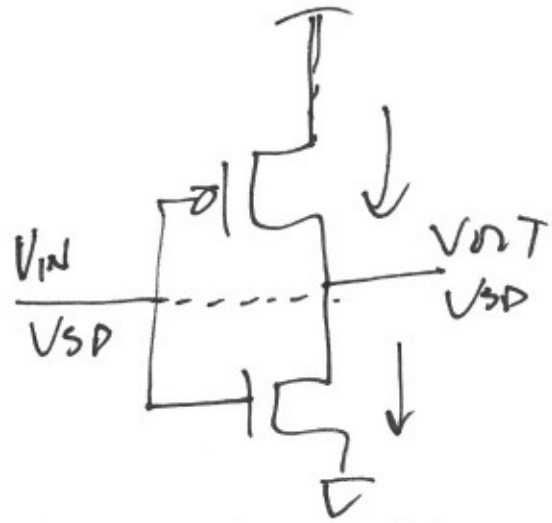
$\frac{\beta_N}{\beta_P}$ ↑ USP ↓



7)


VOUT
VIN

Switching point



$V_{DS} \geq V_{GS} - V_{THN}$

$V_D - V_S \geq V_G - V_S - V_{THN}$

$V_D \geq V_G - V_{THN}$

$0 \geq -V_{THN}$

yes

Saturat.

$$\frac{B_N}{2}(V_{SP} - V_{THN})^2 =$$

$$\frac{B_P}{2}\left(\underbrace{V_{DD} - V_{SP}}_{V_{SG}} - V_{THP}\right)^2$$

$$\sqrt{B_N}\,V_{SP} - V_{THN}\sqrt{B_N} =$$

$$\sqrt{B_P}\,V_{DD} - \sqrt{B_P}\,V_{SP} - \sqrt{B_P}\,V_{THP}$$

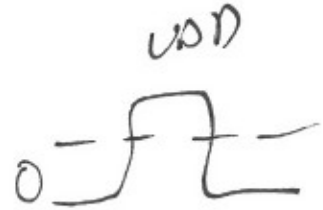
$$V_{SP}\left(\sqrt{B_N} + \sqrt{B_P}\right) =$$

$$V_{THN}\sqrt{B_N} + \sqrt{B_P}\,V_{DD} - \sqrt{B_P}\cdot V_{THP}$$

9)

$$V_{SP} = \frac{V_{THN}\sqrt{\beta_N} + \sqrt{\beta_P}\,V_{DD} - V_{THP}\sqrt{\beta_P}}{\sqrt{\beta_N} + \sqrt{\beta_P}}$$

$$V_{SP} = \frac{V_{DD} - V_{THP} + V_{THN}\cdot\sqrt{\frac{\beta_N}{\beta_P}}}{1 + \sqrt{\frac{\beta_N}{\beta_P}}}$$

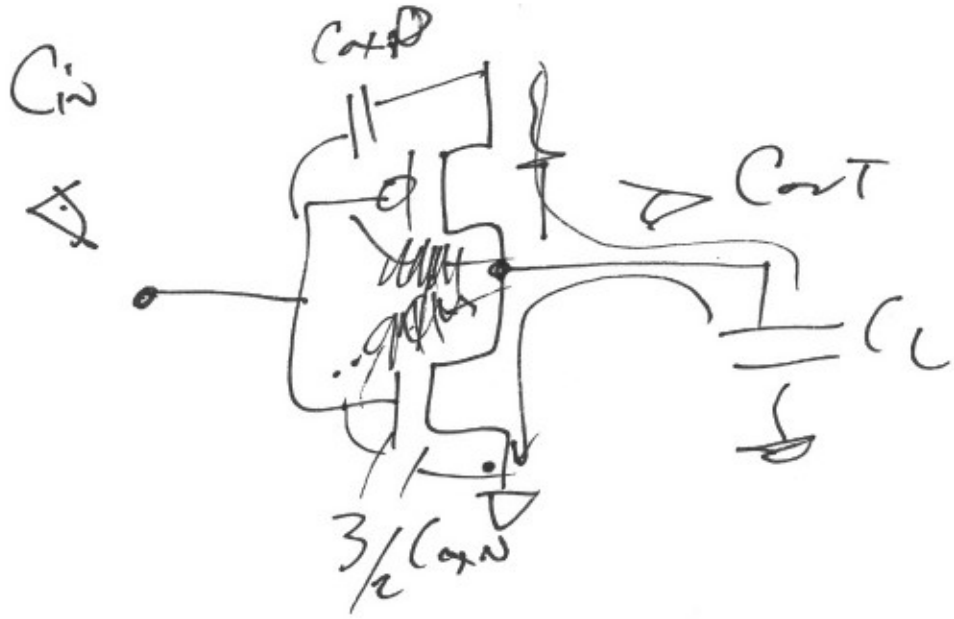


$V_{THN} \simeq V_{THP}$

$\beta_N = \beta_P \leftarrow W_P = W_N \cdot 2$

$V_{SP} = \frac{V_{DD}}{2}$

10)



$$t_{pLH} = 0.7 R_p \cdot C_L$$

$$t_{pHL} = 0.7 R_N C_L$$

$$C_{in} = \frac{3}{2} C_{ox}N + \frac{3}{2} C_{ox}P$$

$$C_{ox}T = C_{ox}N + C_{ox}P$$