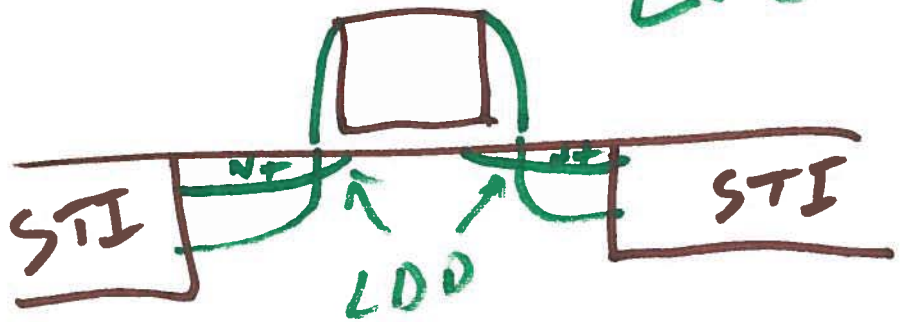
EE 421/ECG 621

Digital IC Design

Oct. 3, 2016

Lecture 10



p-sub

Lightly doped drain

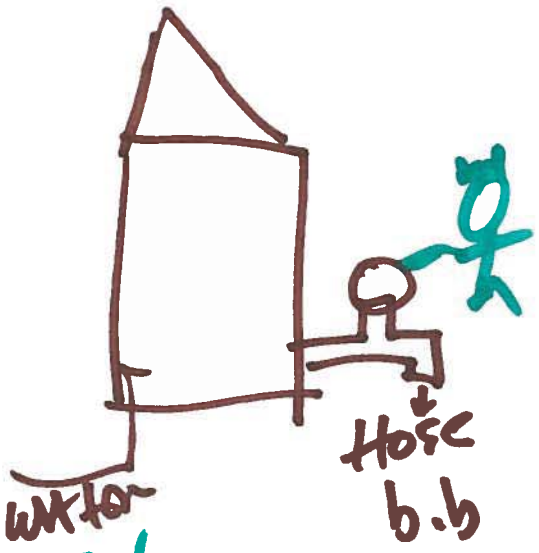
LDD

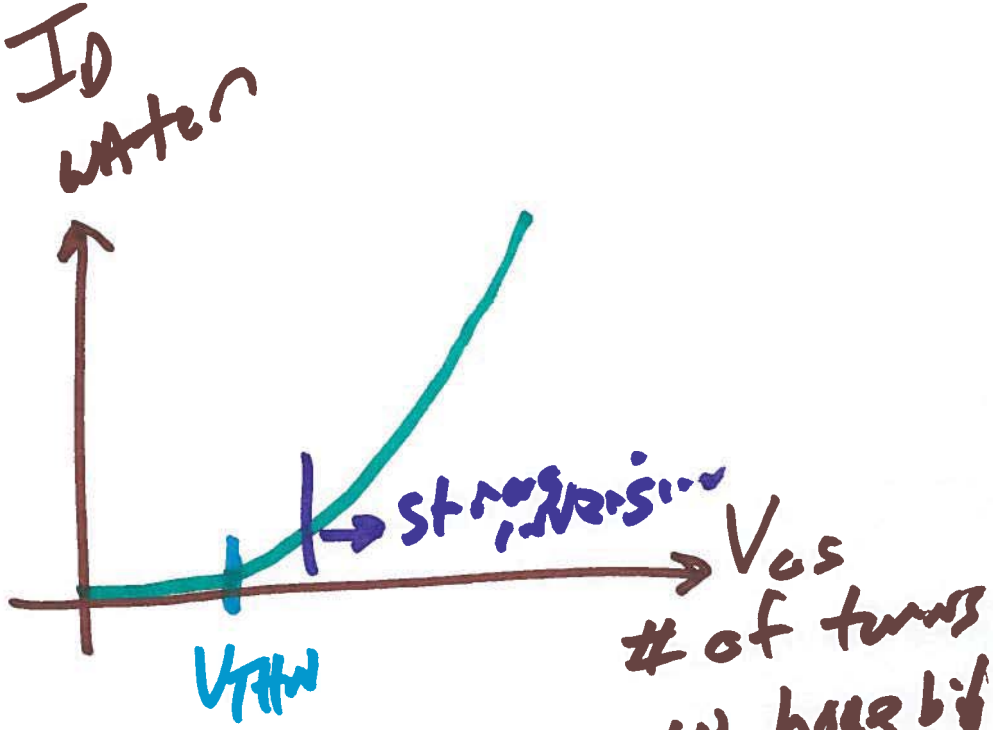
reduces lateral diffusion

I_D v. V_{GS}

v. V_{SG}

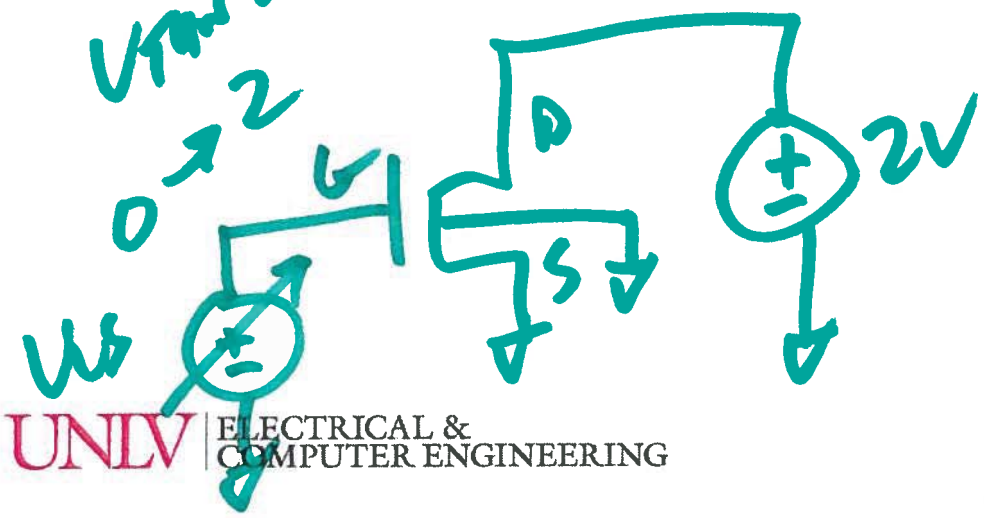
$1K \| 2K = 666$

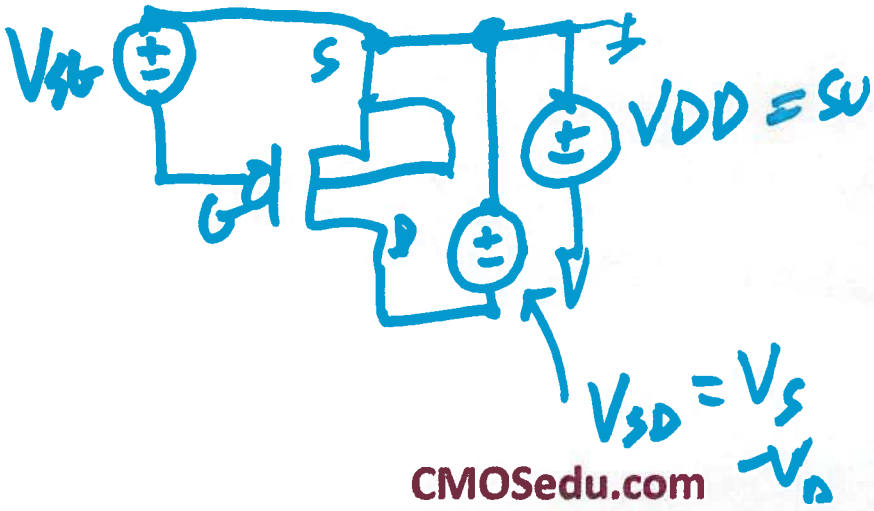


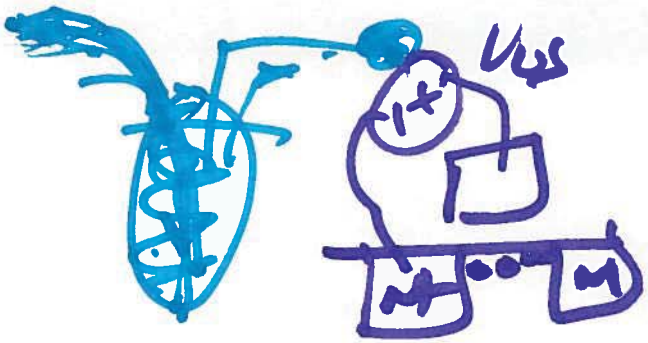


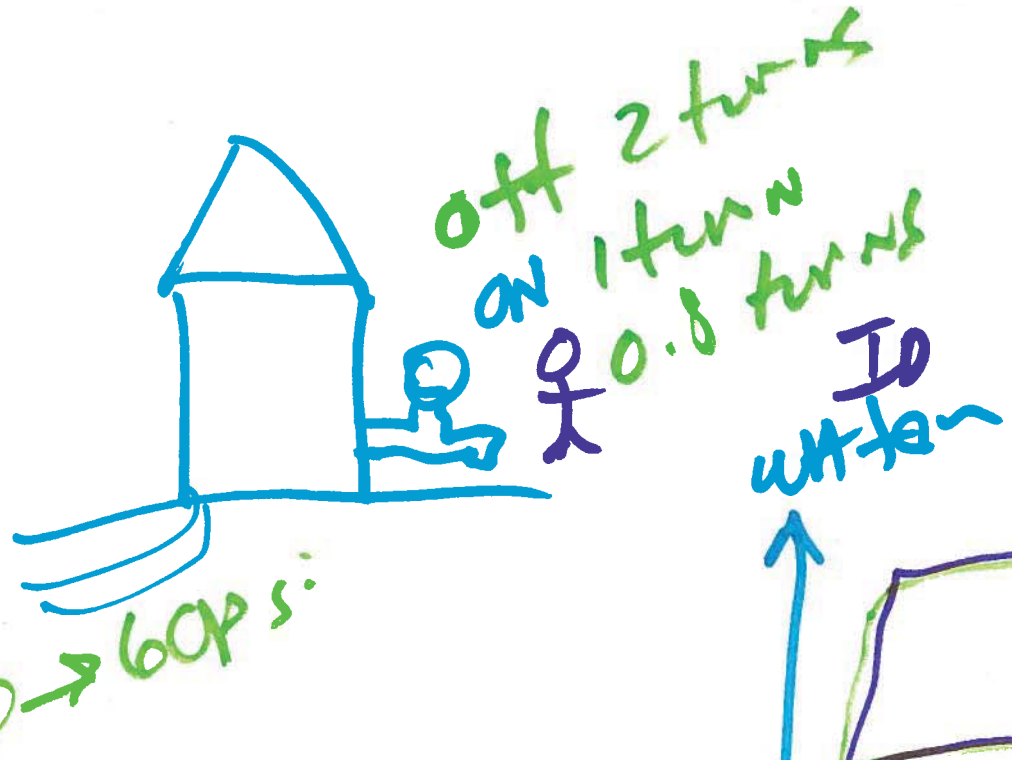
$V_{TH} = 0.8V$

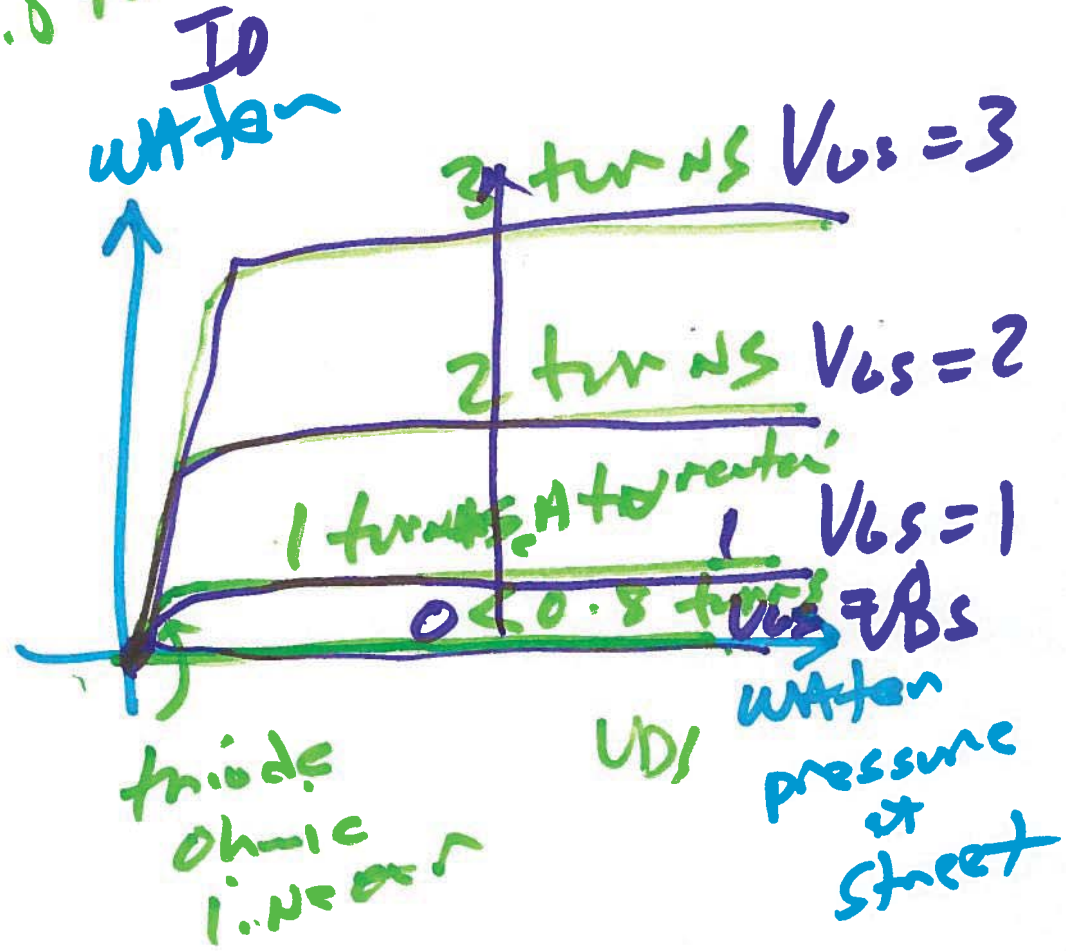
$0 \rightarrow 2$

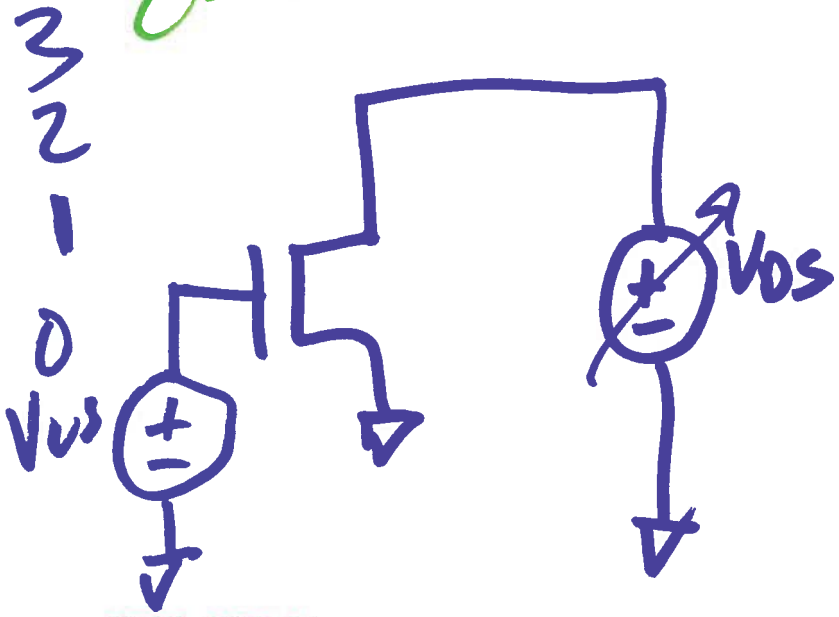


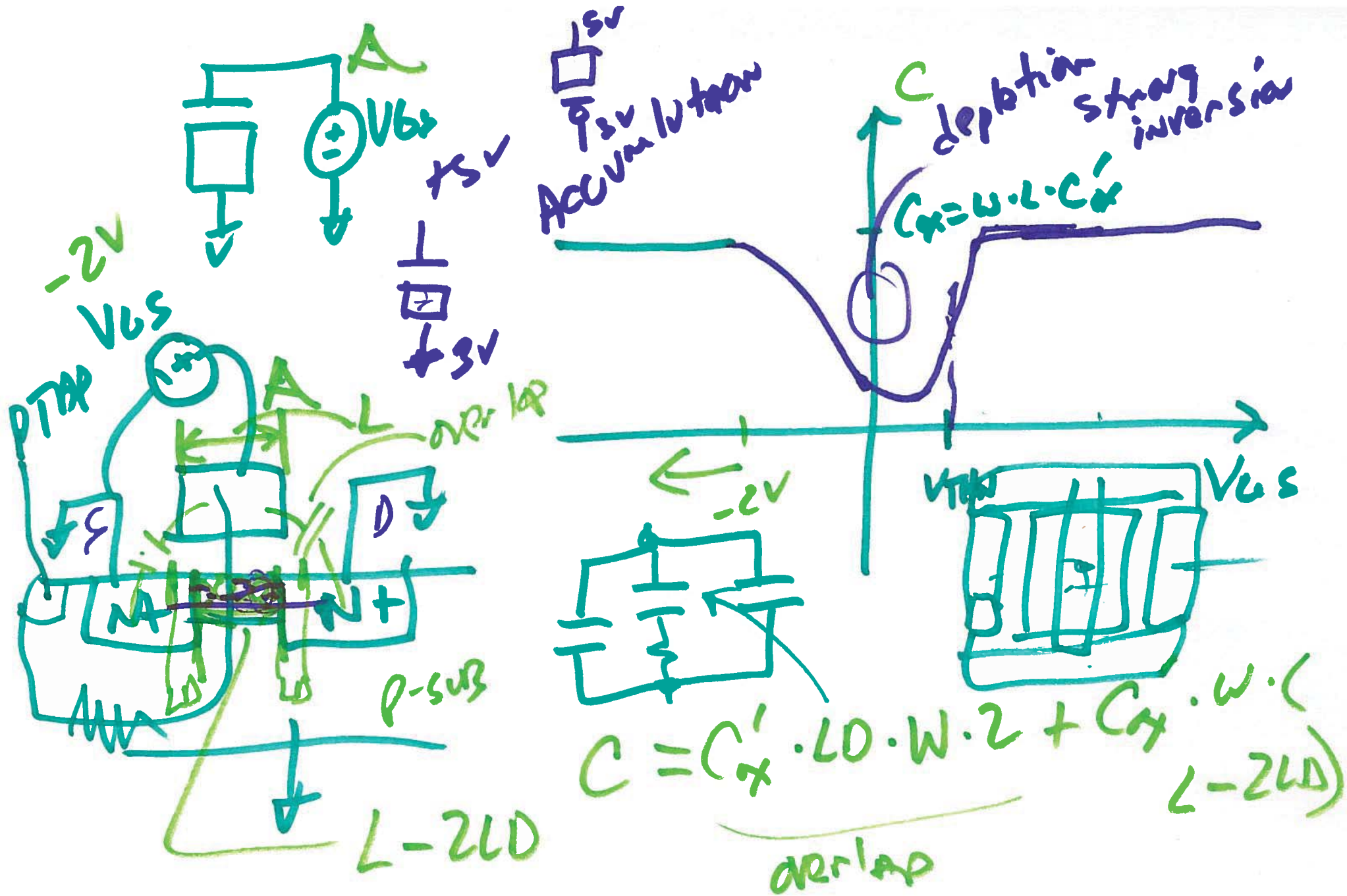


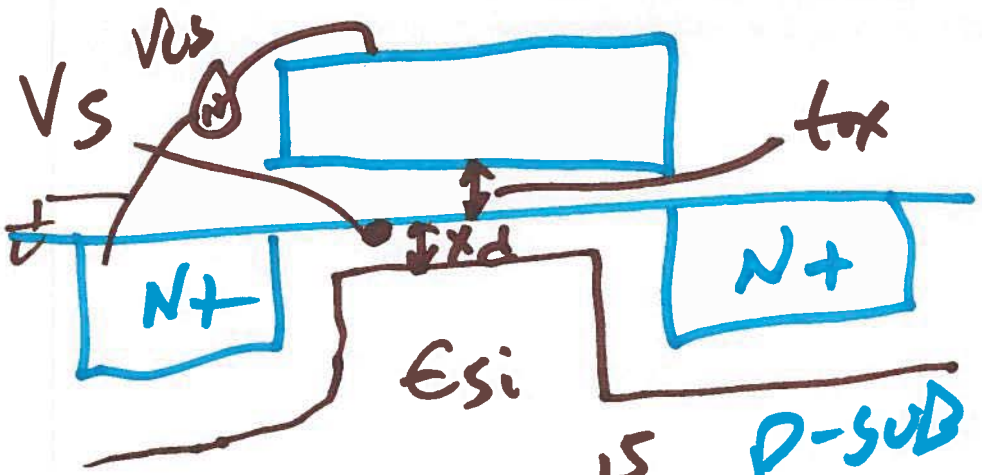

VGS


off 2 turns
on 1 turn
0.8 turns
0 → 60 psi


ID
water
3 turns VGS = 3
2 turns VGS = 2
1 turn VGS = 1
0 < 0.8 turns
VDS
water pressure at street
triode
ohmic
linear
VDD


M2
M1
M0
VDS
VDD


A
VGS
+5V
Psv
Accumulation
C
depletion
strong inversion
$C_{ox}=W\cdot L\cdot C'_{ox}$
-2V
VGS
PMOS
A
L
overlap
G
D
NA
N+
LD
P-SUB
L-2LD
-2V
VTHN
VGS
$C = C'_{ox}\cdot LD\cdot W\cdot 2 + C_{ox}\cdot W\cdot($
$L-2LD)$
overlap



V_{GS}

$V_S = 2|V_{fp}|$

$V_S = \frac{KT}{q} \ln\left(\frac{N}{N_i}\right)$

$V_{GS} = 0$

$V_S = V_{fb} \Rightarrow$ Neg. ±

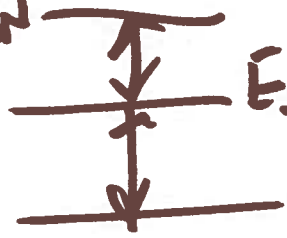
$V_S = 0 \rightarrow +300mV = V_{TS}$

$V_S = |\pm V_{fp}| \rightarrow +600mV$

V_{GS}

$$X_d = \sqrt{\frac{2\varepsilon_{si}(V_S - V_{fp})}{qN_A}}$$

$$V_{fp} = -\frac{KT}{q} \ln\frac{N_A}{N_i}$$



$$X_d = \sqrt{\frac{2\epsilon_{si}|V_s - V_{fp}|}{qN_A}}, \quad V_{fp} = \frac{E_i - E_{fp}}{q} = \frac{KT}{q} \ln \frac{N}{N_A}$$

$$Q_b = Q_b' \cdot W \cdot L$$

$$Q_b' = qN_A \cdot X_d = \sqrt{2\epsilon_{si} \cdot qN_A |V_s - V_{fp}|}$$

$V_s = V_{fp}$ Neg

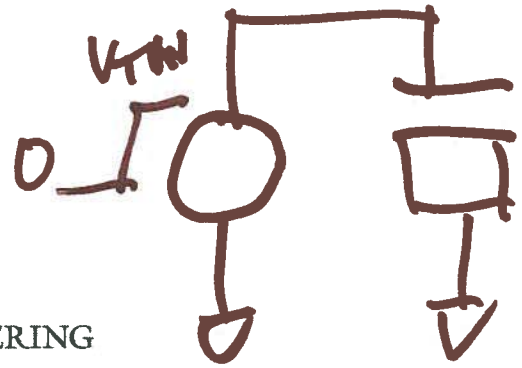
$V_s = 0$

$V_s = -V_{fp}$ pos

At $V_{GS} = V_{THN}$

$$Q_b' = \sqrt{2\epsilon_{si} \cdot qN_A |2V_{fp}|}$$

$CV = Q$



$$C = V_{THN} = Q_b'$$