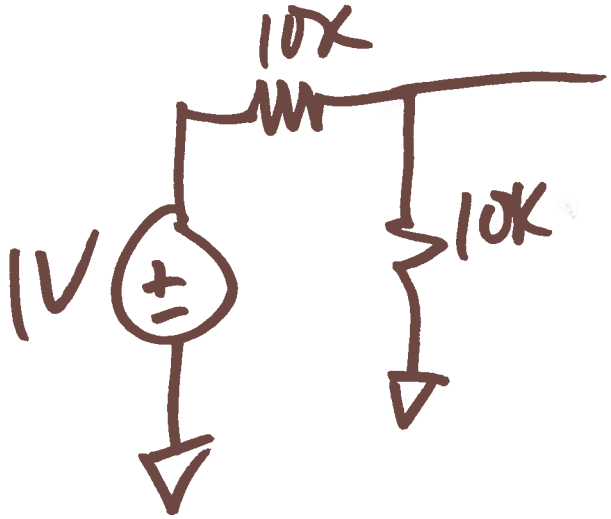
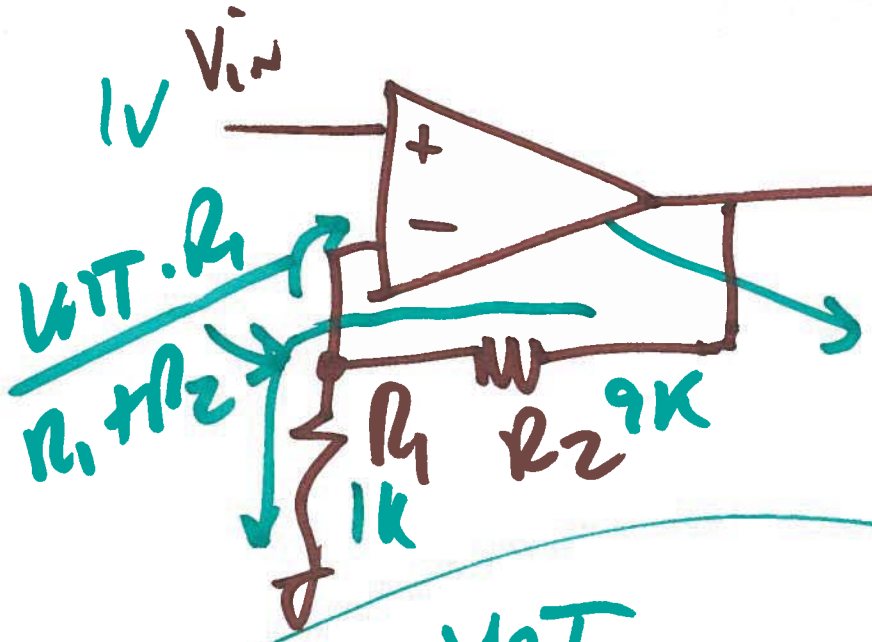
EE 421/ECG 621
Digital IC Design
Lecture 9
Sept. 28, 2016



$$V_{OUT} = 1 \cdot \frac{10K}{10K + 10K} = \frac{1}{2}$$

$$= 1 \cdot \frac{12K}{12K + 12K} = \frac{1}{2}$$



$$I = \frac{V_{OUT}}{R_1+R_2}$$

$$V_- = I \cdot R_1$$

$$V_+ = V_{OUT} \cdot \frac{R_1}{R_1+R_2}$$

$$V_{OUT} = V_{IN} \cdot \frac{\infty}{1+\frac{R_1}{R_1+R_2}\cdot\infty}$$

$$V_{OUT} = \left(V_{IN} - V_{OUT} \cdot \frac{R_1}{R_1+R_2}\right) \cdot \infty$$

$$V_{OUT}\left(1 + \frac{R_1}{R_1+R_2}\cdot\infty\right) = V_{IN}\cdot\infty$$

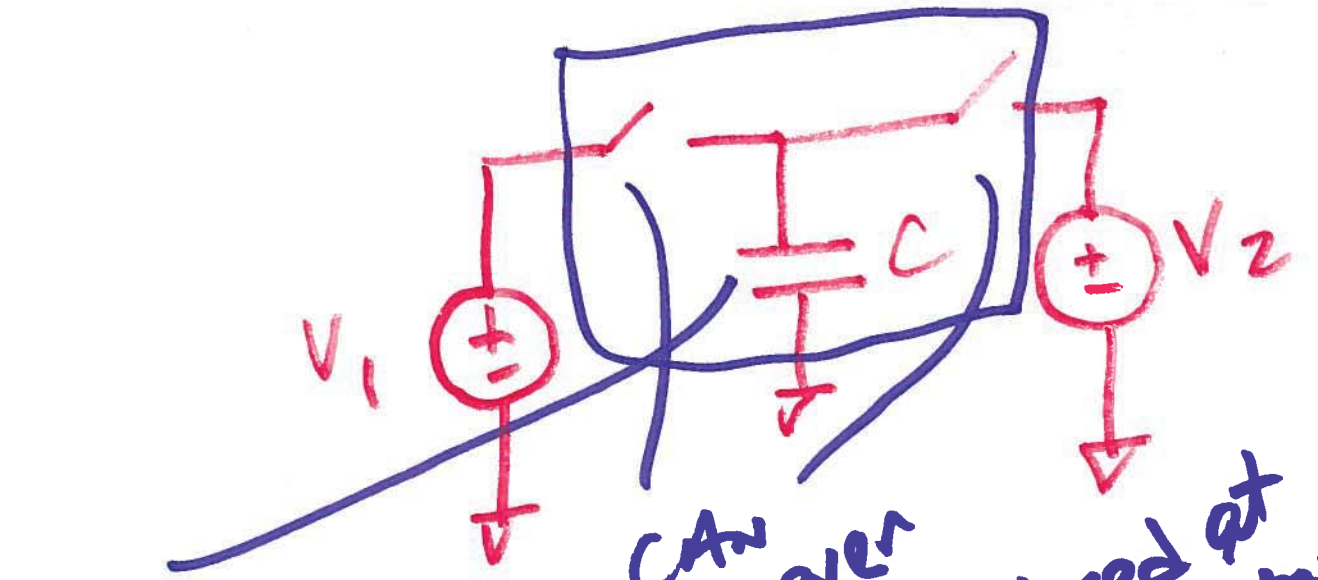
$$V_{OUT} = V_{IN} \cdot \frac{\infty}{1 + \frac{R_1}{R_1+R_2} \cdot \infty}$$

$$V_{OUT} = \frac{V_{IN}}{\cancel{\frac{1}{\infty}} + \frac{R_1}{R_1+R_2}} = V_{IN} \cdot \left(\frac{R_1+R_2}{R_1}\right)$$

$\infty \rightarrow 0$

$$V_{OUT} = V_{IN} \cdot \left(1 + \frac{R_2}{R_1}\right)$$

Switched-capacitor



$Q = CV$

$T_{CLK} = \frac{1}{f}$

R_{SC}

CAN NEVER be closed at same time

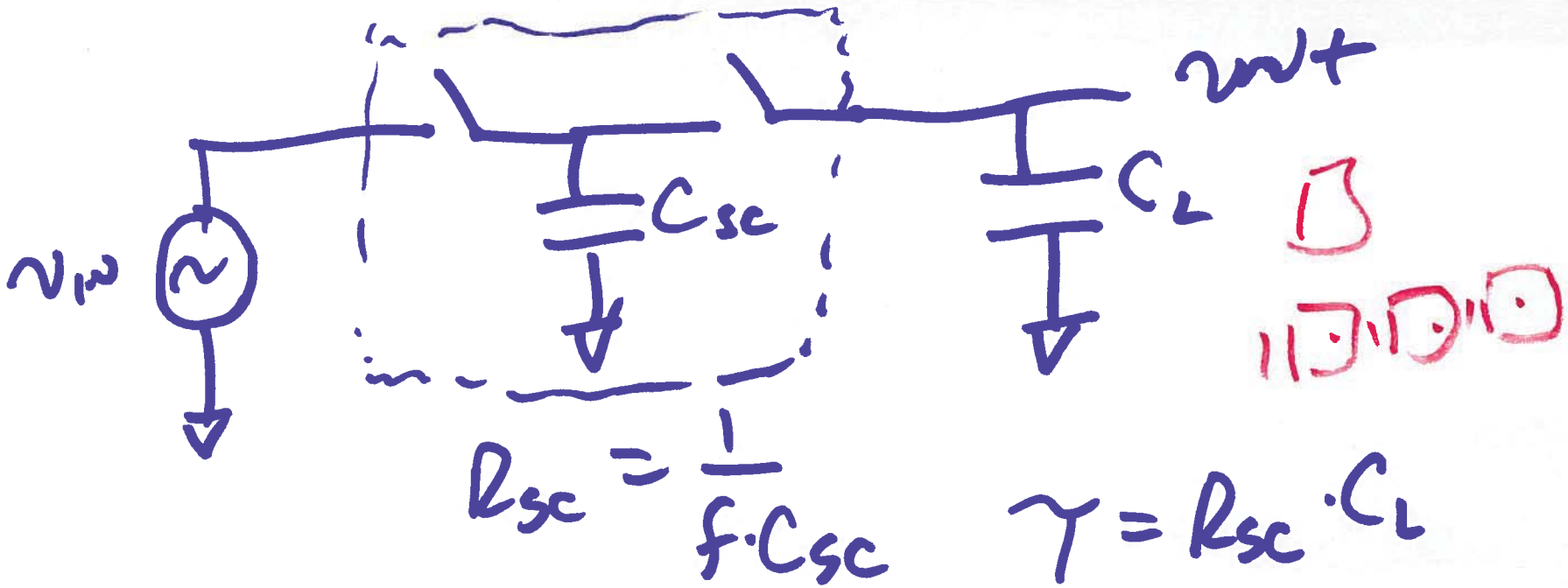
$\Delta Q = C \cdot V_1 - C \cdot V_2$

$$I_{AVG} = \frac{\Delta Q}{T_{CLK}} = \frac{C(V_1 - V_2)}{T_{CLK}}$$

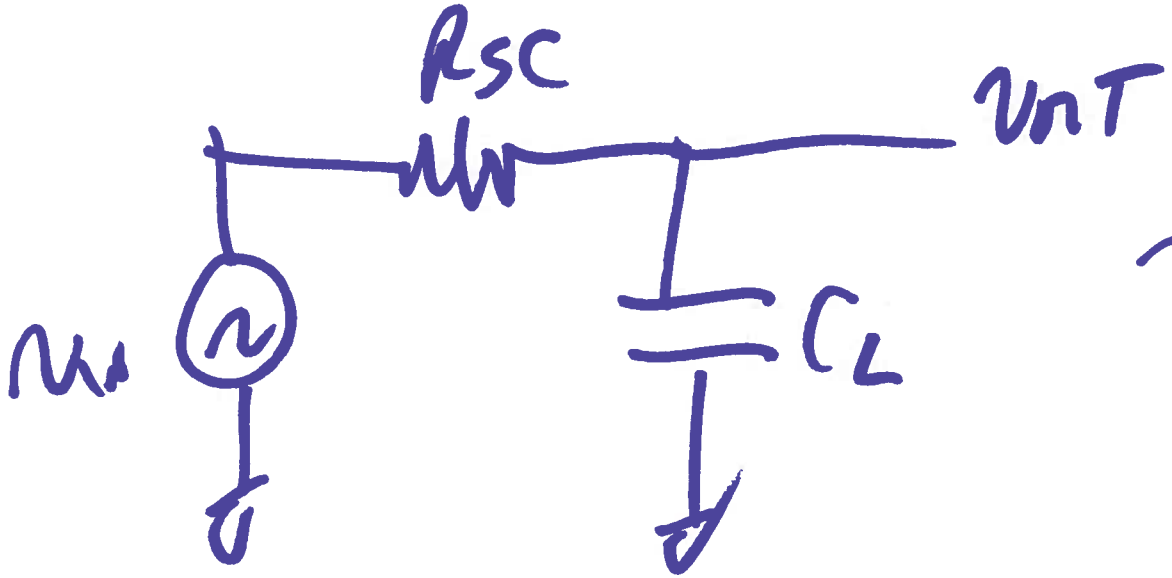
R_{SC}

$$V_1 - V_2 = I_{AVG} \cdot \frac{1}{fC}$$

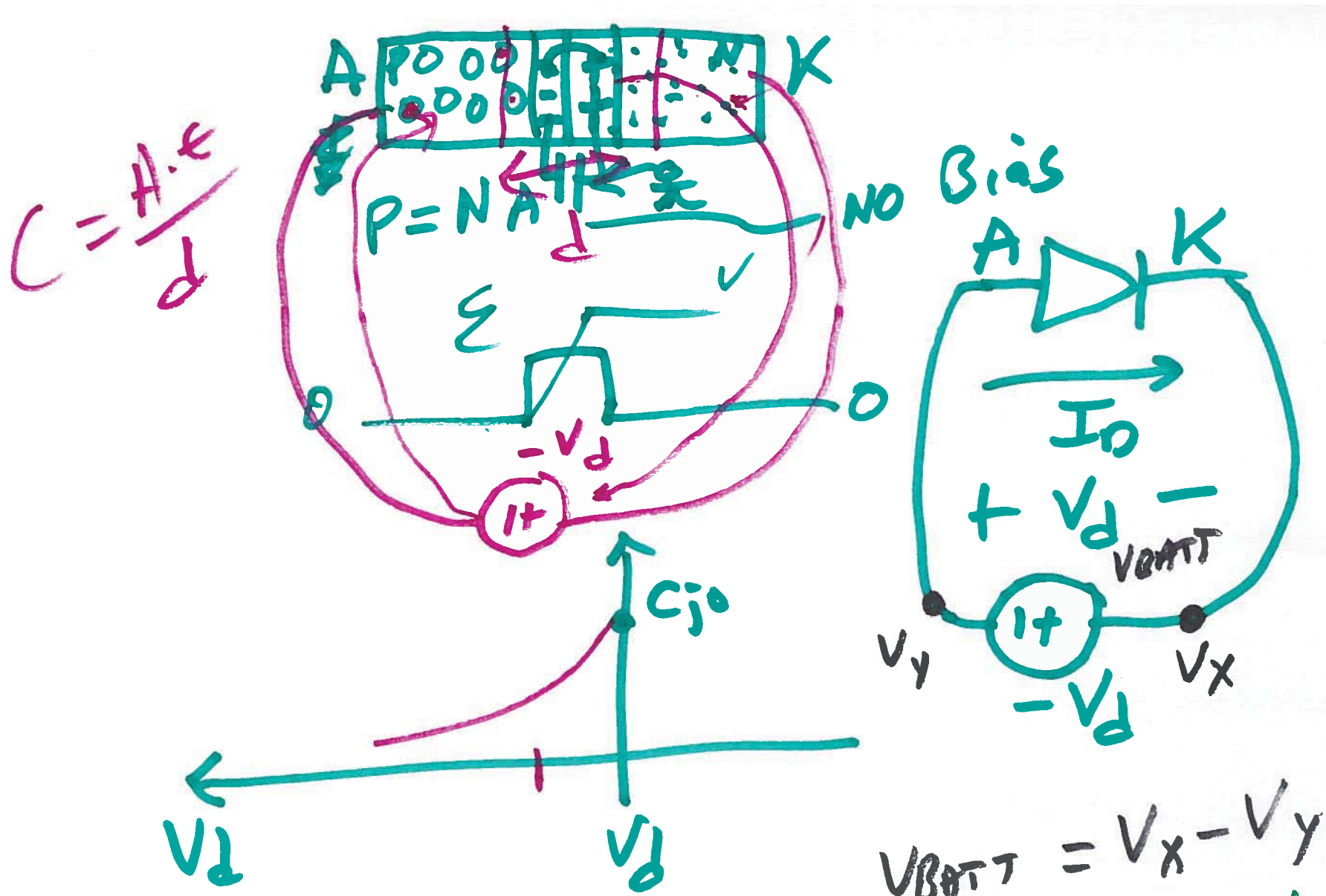
$$fC \cdot (V_1 - V_2)$$



$$R_{sc} = \frac{1}{f \cdot C_{sc}} \qquad \tau = R_{sc} \cdot C_L$$



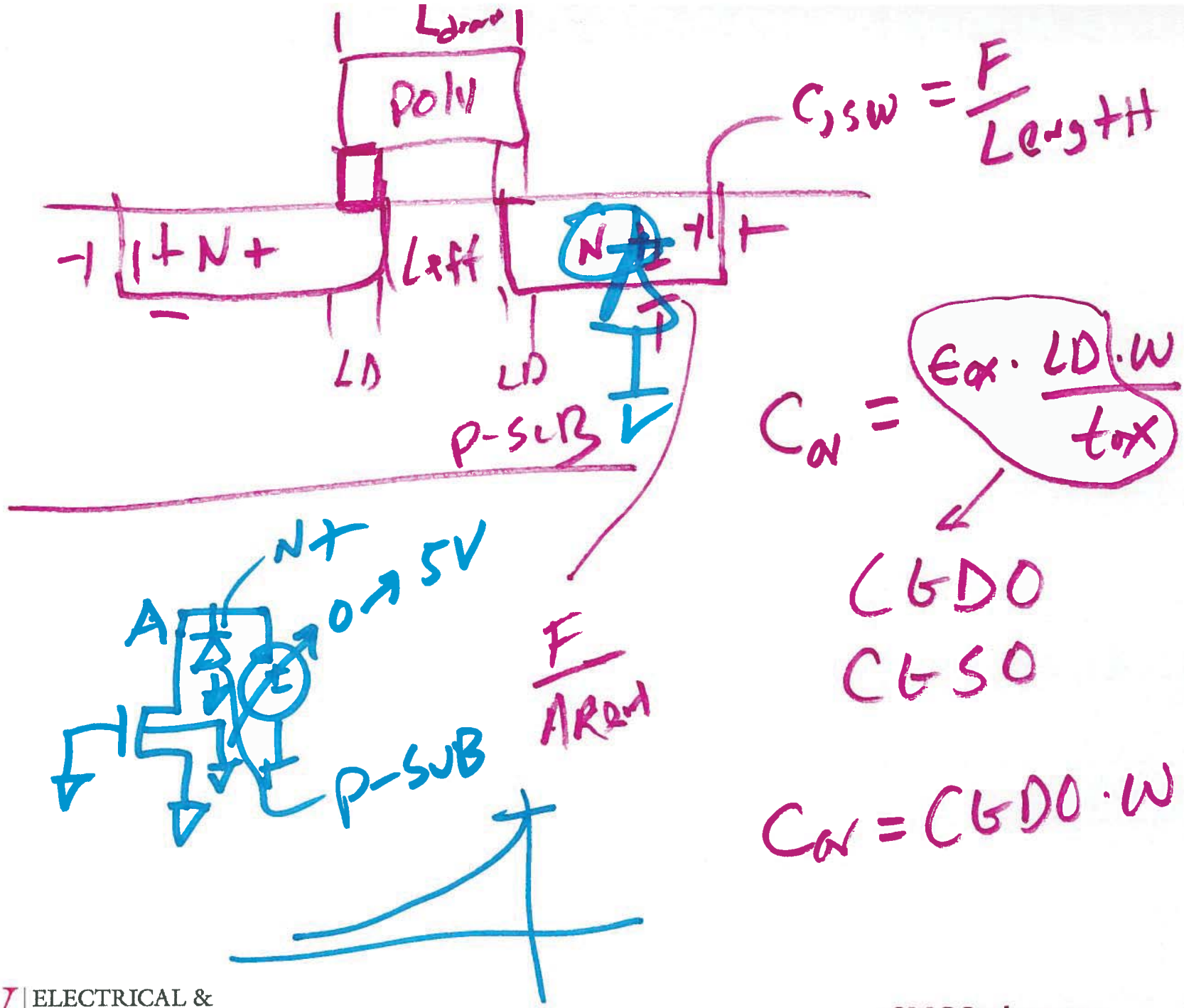
$$\tau = \frac{1}{f} \cdot \frac{C_L}{C_{sc}}$$

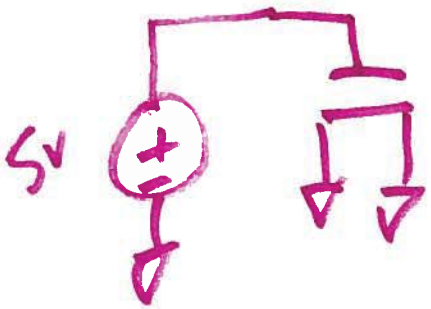


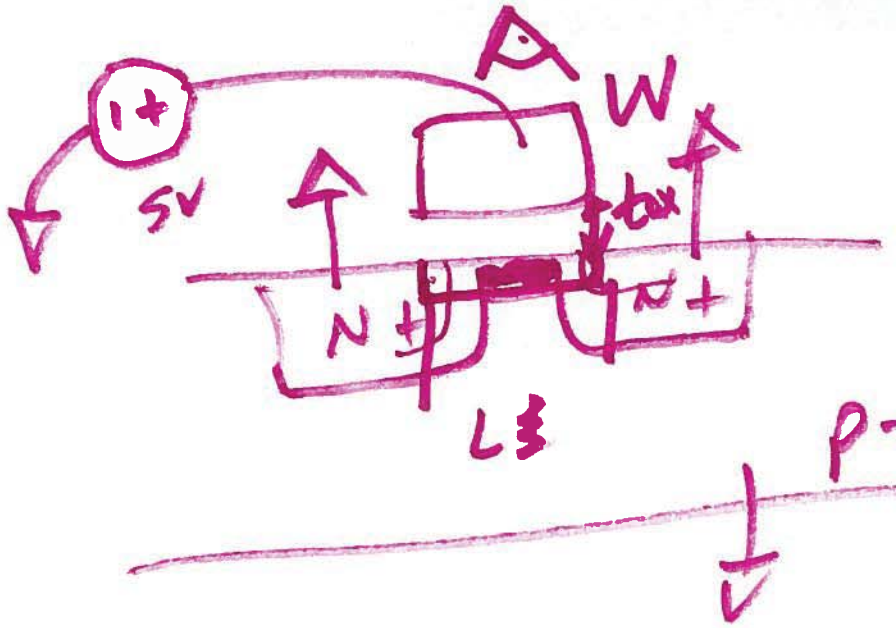
$$V_{BATT} = V_x - V_y$$

$$-V_d = V_x - V_y$$

$$V_d = V_y - V_x$$


Lgate
poly
N+
N+
Left
LD
LD
p-sub
$C_{jsw} = \frac{F}{Length}$
$C_{ol} = \frac{\epsilon_{ox} \cdot LD \cdot W}{t_{ox}}$
C_{GDO}
C_{GSO}
N+
A
0 → 5V
p-SUB
$\frac{F}{A_{RGN}}$
$C_{ol} = C_{GDO} \cdot W$



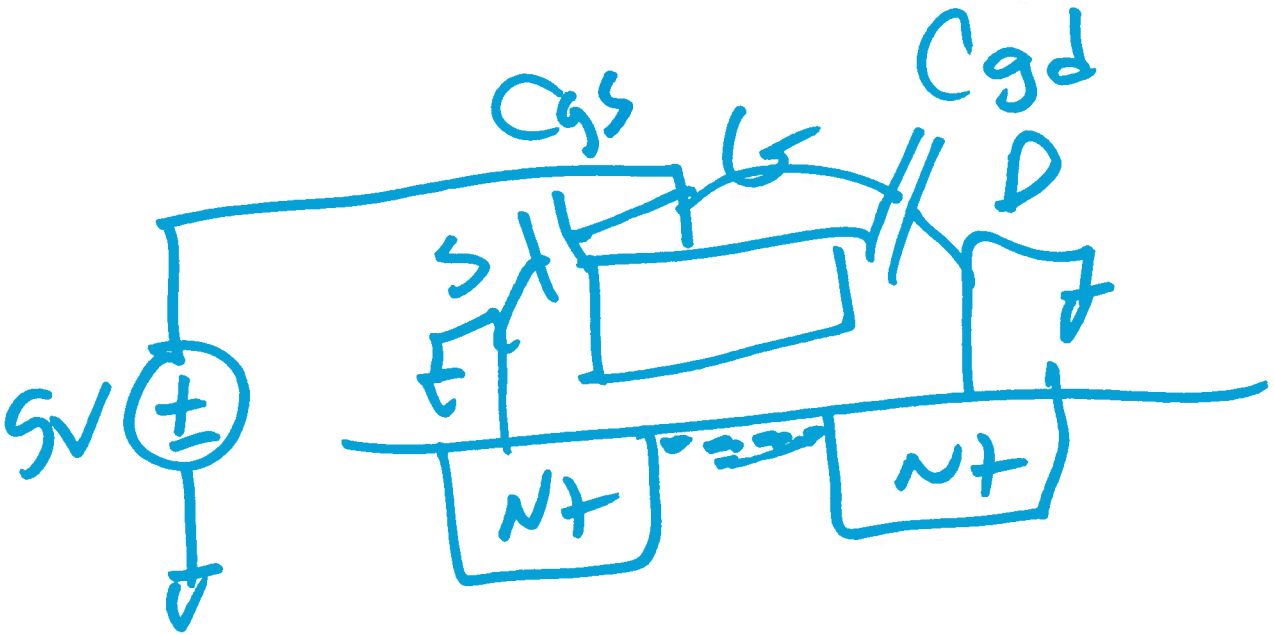


$$C = \frac{\epsilon A}{t}$$

$$C_{ox} = \frac{\epsilon_{ox}}{t_{ox}} \cdot L \cdot W = C_{ox}' \cdot L \cdot W$$

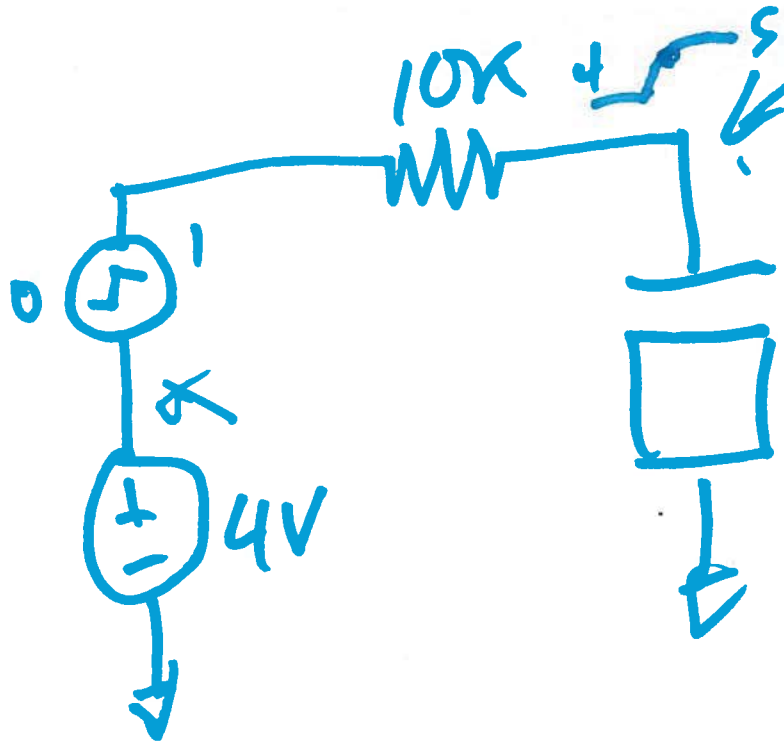
$$\frac{\epsilon_{ox}}{t_{ox}} = \frac{3.97 \cdot 8.85\ aF/\mu m}{0.0141\ \mu m} = 2.5\ fF/\mu m^2$$

C_{ox}' $\left(\frac{F}{Area} = \frac{F}{\mu m^2}\right)$



$$C_{ox} = C_{gs} + C_{gd} = C'_{ox} \cdot W \cdot L$$

$$C_{gs} = C_{gd} = \frac{1}{2} C_{ox}$$



Calculate and sketch

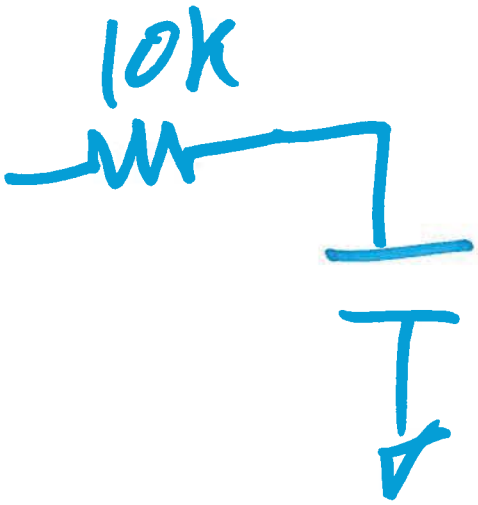
W x L

100n x 100n

$W/L = \frac{100}{100}$

$\tau = 250\,ns$

25pF



100n * 100n · 2.5fF / n²

0.7 · [redacted] · 250n