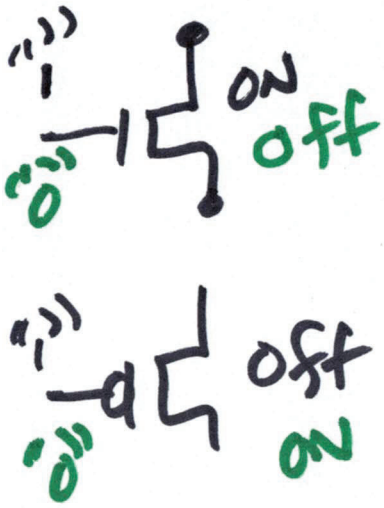
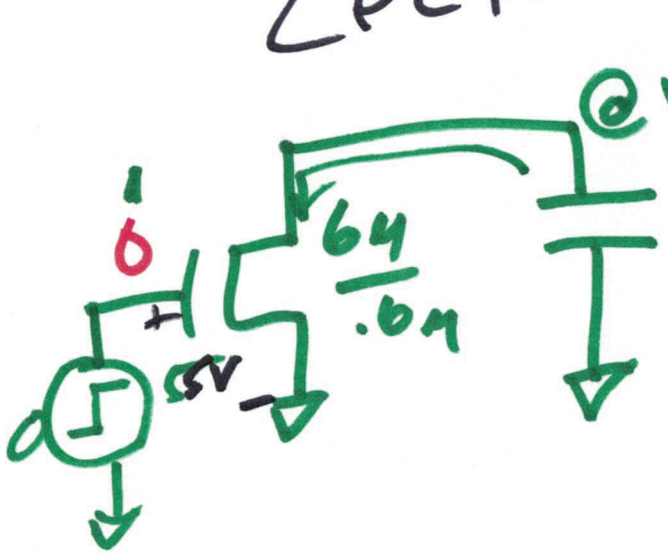
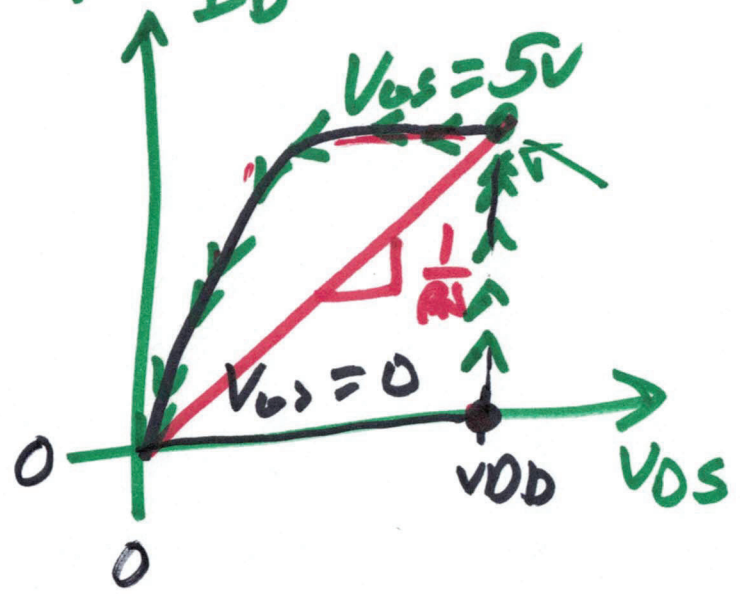
EE 421 / ECG 621
Digital IC Design
October 23, 2023
Lecture 15

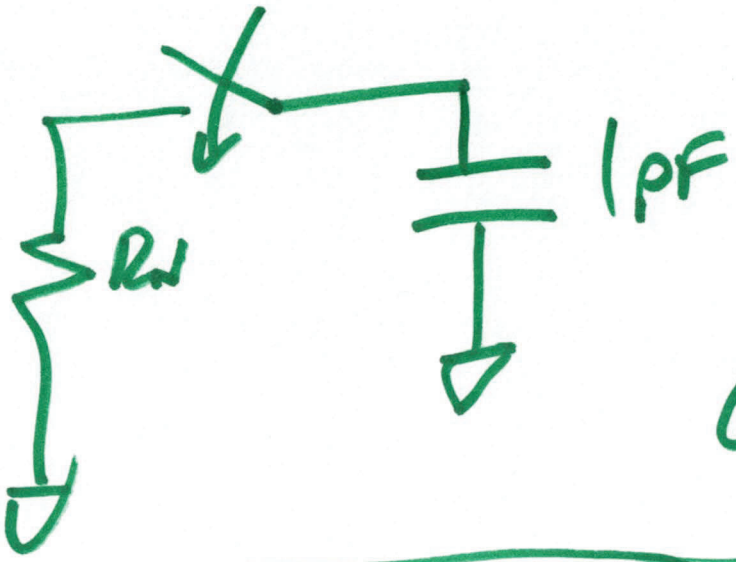


$KP = \mu_N \cdot C_{ox}$



$$R_N = \frac{VDD}{\frac{KP}{2} \cdot \frac{W}{L}\left(VDD - V_{TN}\right)^2}$$





$0.7 R_N \cdot 1\,pF$

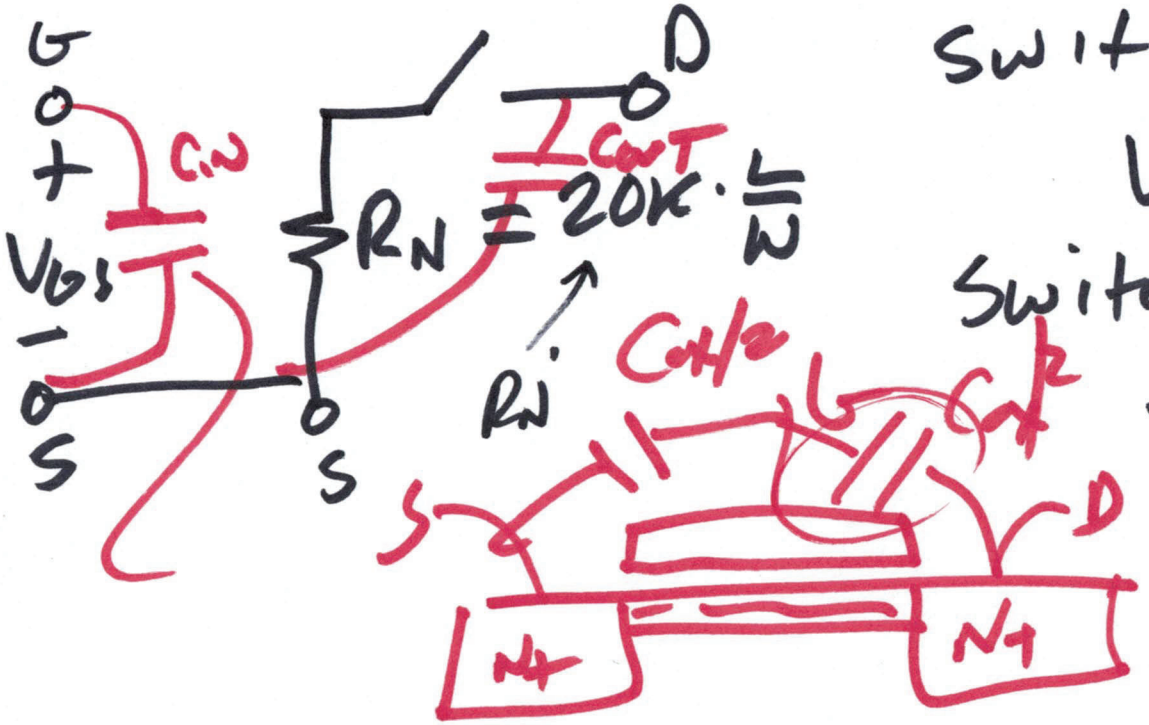
$$R_N = R_N' \cdot \frac{L}{W}$$

$$C_{ox} = C_{ox}' \cdot L \cdot W$$

$$R_P = R_P' \cdot \frac{L}{W}$$

$$R_N = \frac{5}{2.5\,mA} = 2K = R_N' \cdot \frac{L}{W} = R_N' \cdot \frac{0.6}{6}$$

$$R_N' = 20K$$



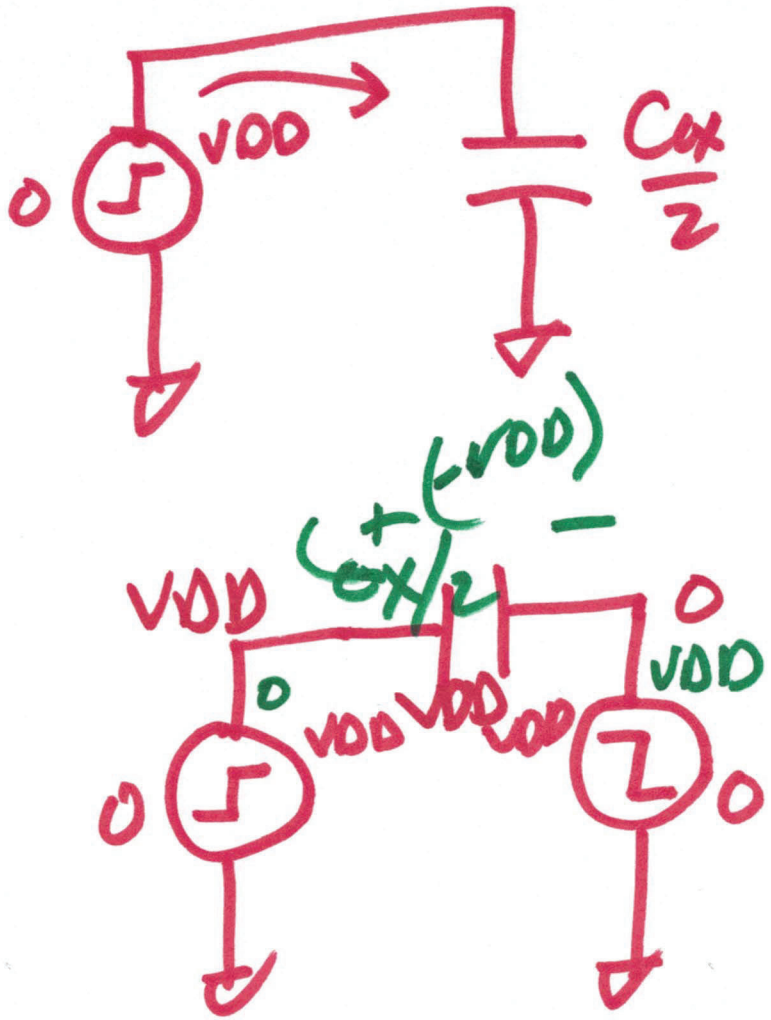
Switch closed

$$V_{GS} > \frac{V_{DD}}{2}$$

Switch open

$$V_{GS} < \frac{V_{DD}}{2}$$

$CV = Q$



$$\frac{C_{ox}}{2} \cdot VDD = Q$$

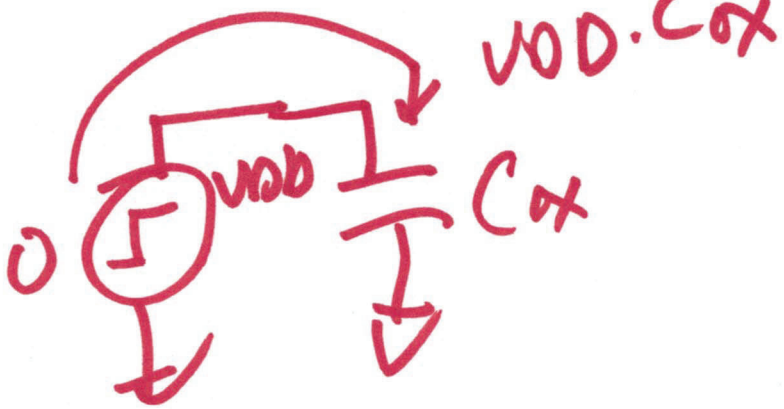
$$Q_i = -VDD \cdot \frac{C_{ox}}{2}$$

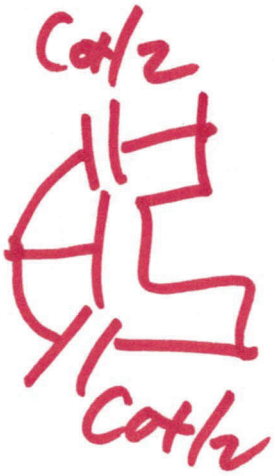
$$Q_f = VDD \cdot \frac{C_{ox}}{2}$$

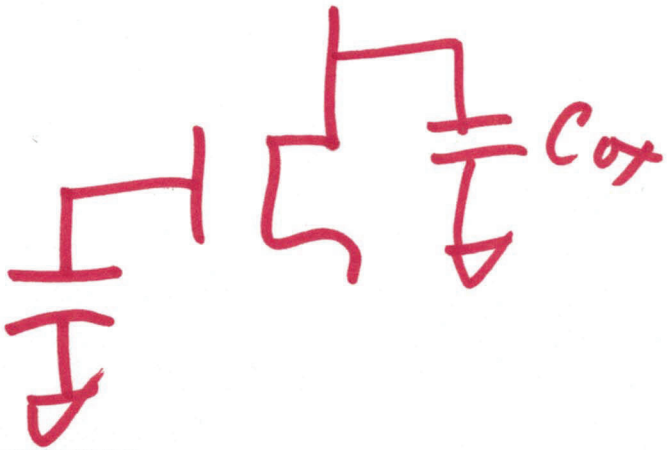
$$2VDD \cdot \frac{C_{ox}}{2}$$

$$VDD \cdot C_{ox}$$

$Q = VDD \cdot Cox$

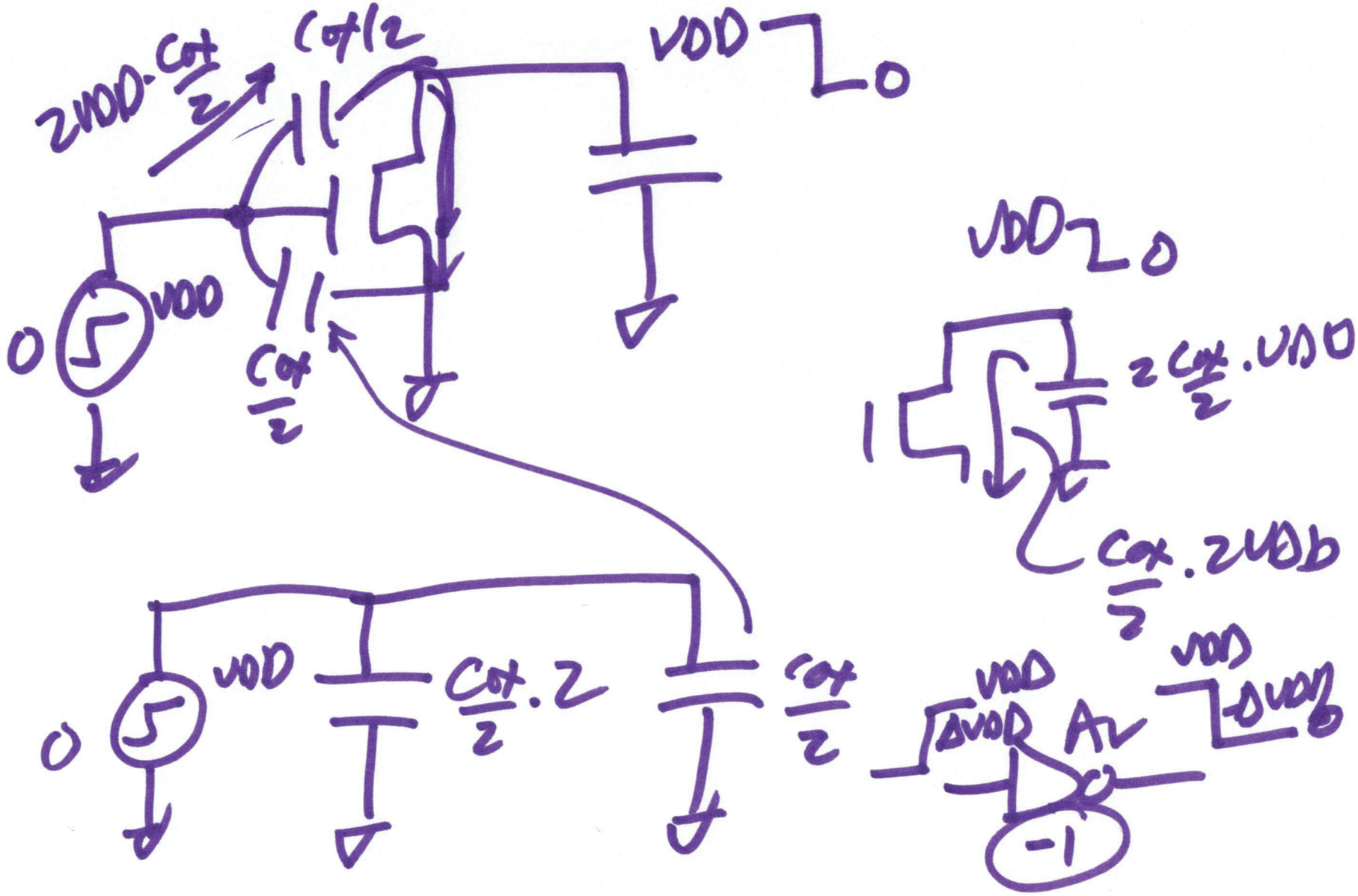




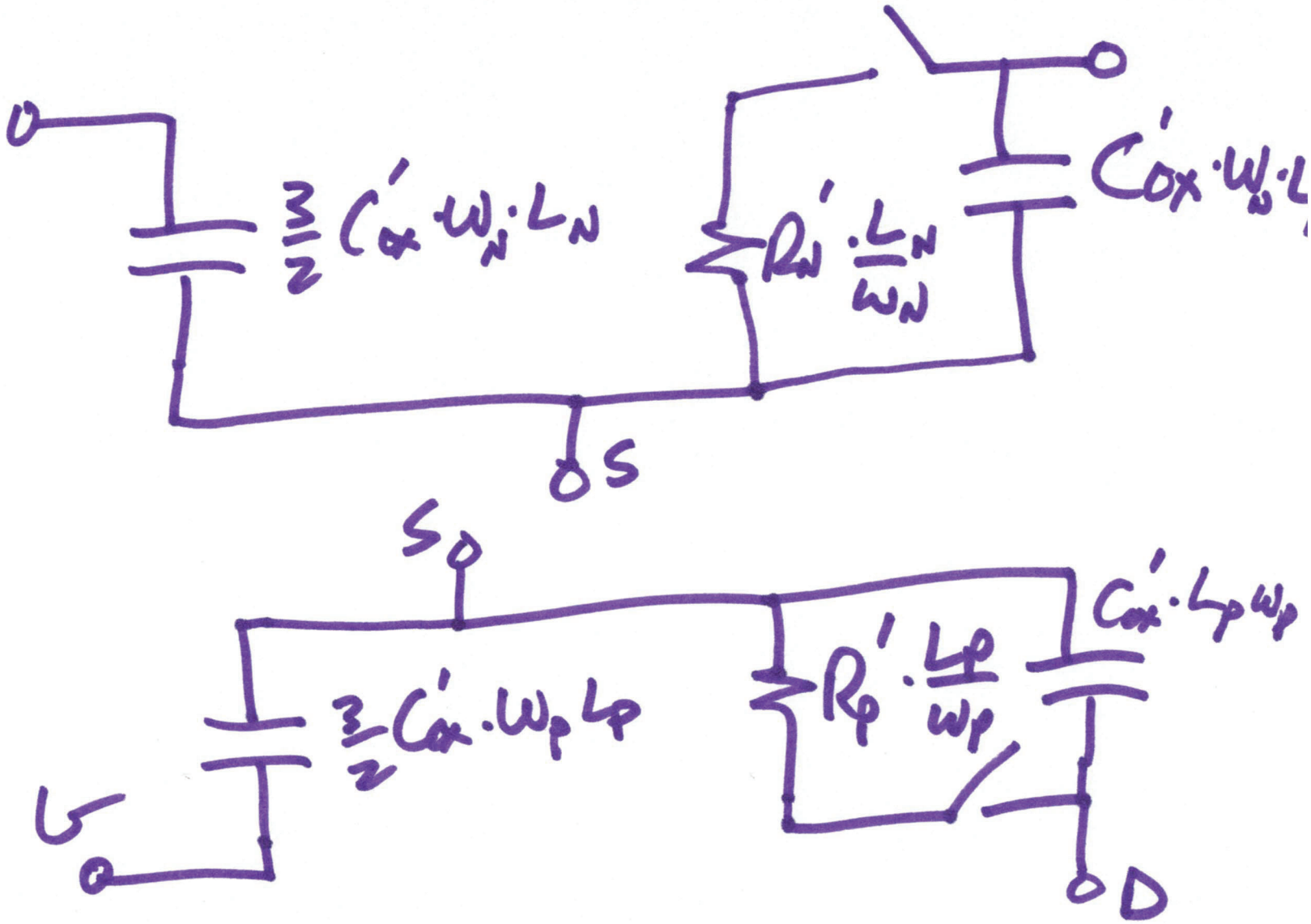


$\frac{3}{2} Cox + \frac{Cox}{2}$

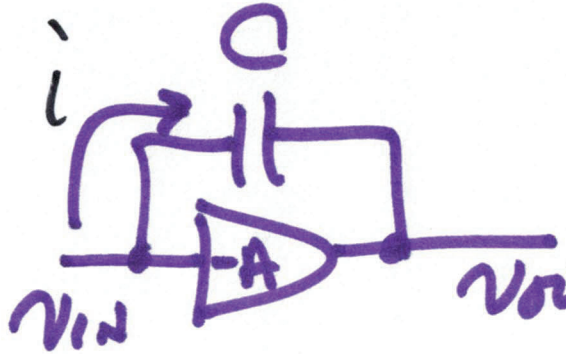
5)


2VDD-Cox/2
Cox/2
VDD
0
VDD
Cox/2
VDD
0
2Cox/2.VDD
Cox.2VDb/2
VDD
0
VDD
Cox/2.2
Cox/2
VDD
ΔVOR
AV
VDD
-ΔVOR
-1

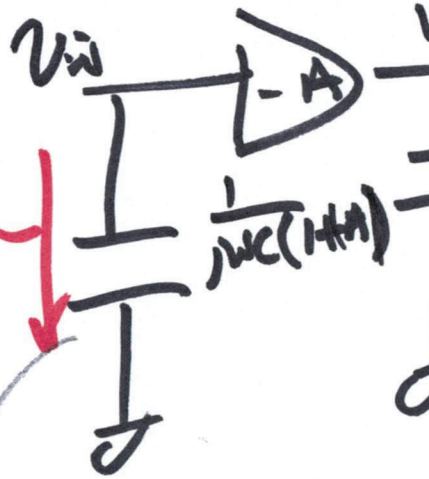
Digital Model



$\frac{v_{in}}{\frac{1}{j\omega C(1+|A|)}}$



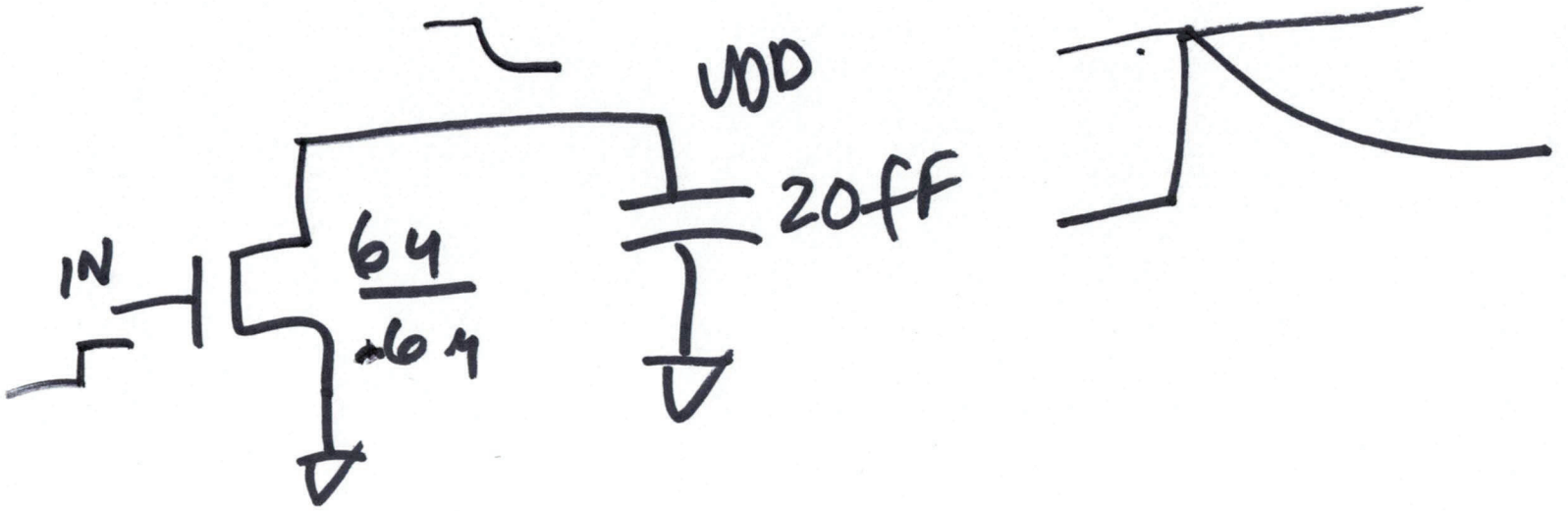
$$i = \frac{v_{in} - (-A \cdot v_{in})}{\frac{1}{j\omega C}\left(1+\frac{1}{A}\right)} = \frac{\left(\frac{v_{out}}{-A} - v_{out}\right)}{\frac{1}{j\omega C}}$$

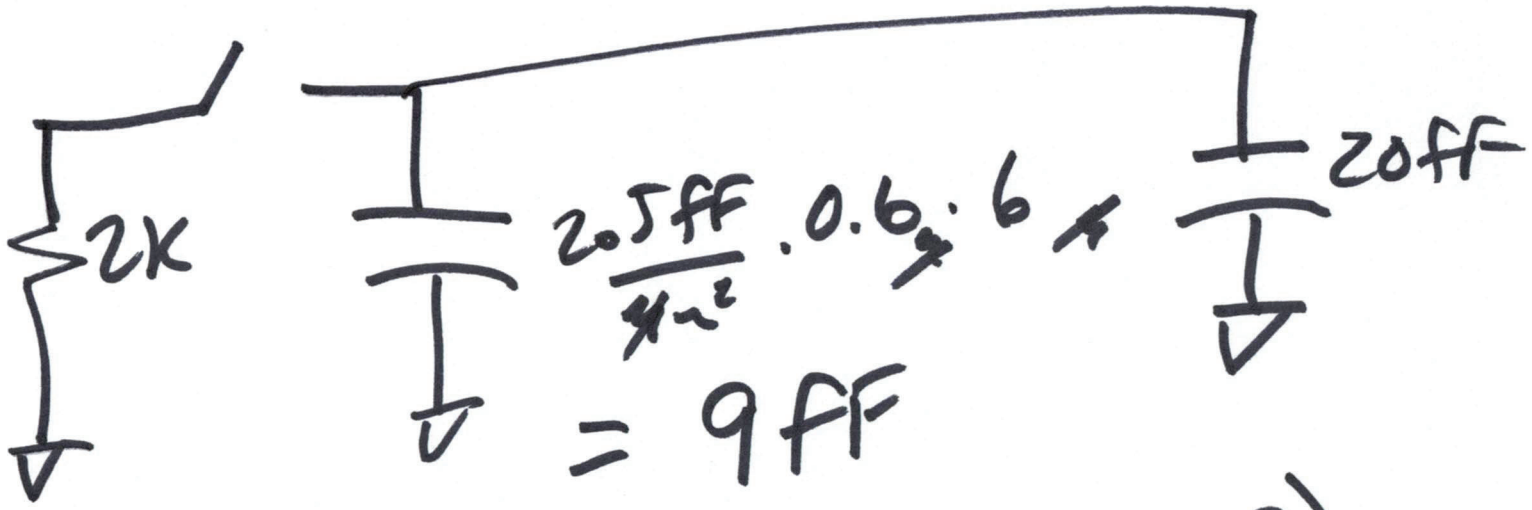


$$\frac{v_{in}(1+|A|)}{\frac{1}{j\omega C}} \cdot \frac{1}{1+|A|} = \frac{v_{out}\left(1+\frac{1}{|A|}\right)}{\frac{1}{j\omega C}}$$

$$\frac{v_{in}}{\frac{1}{j\omega C(1+|A|)}} = \frac{v_{out}}{\frac{1}{j\omega C\left(1+\frac{1}{|A|}\right)}}$$

8)





$$\frac{20fF}{\mu m^2} \cdot 0.6\mu \cdot 6\mu = 9fF$$

$$t_d = 0.7 \cdot 2K\,(9fF + 20fF)$$

$$\boxed{t_d = 40\,ps}$$