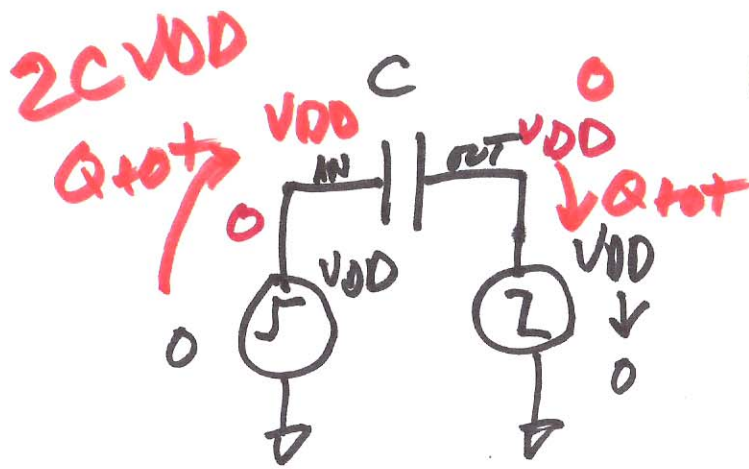


Miller Capacitance

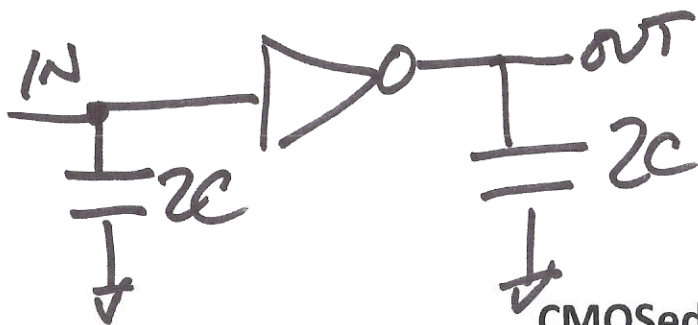
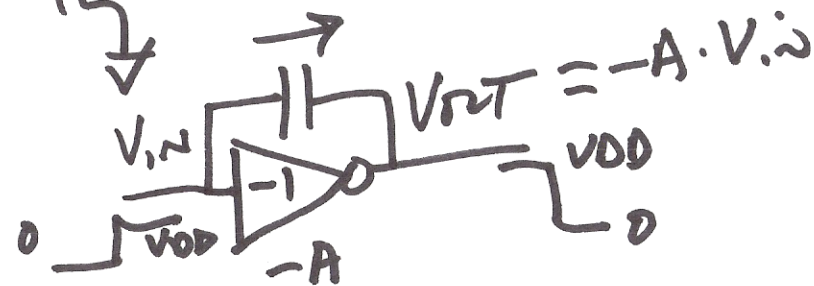
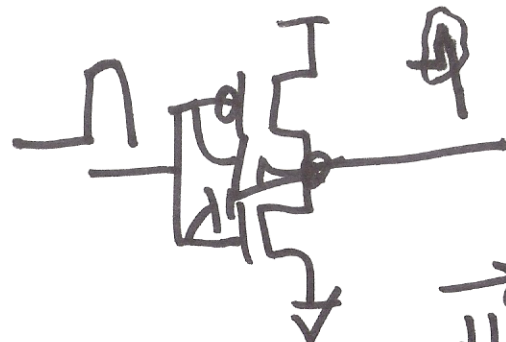
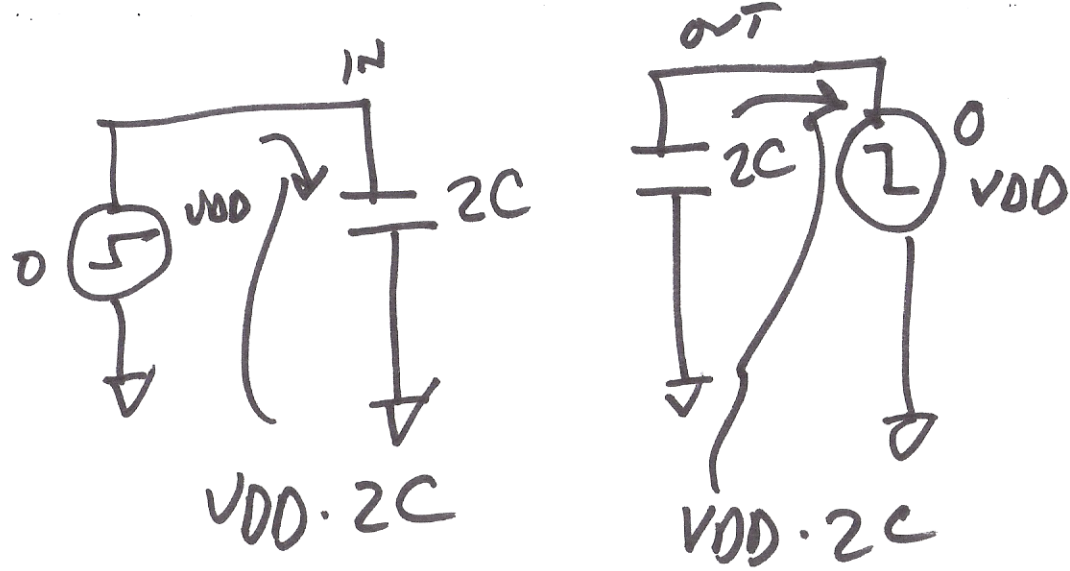


Before switching

$$Q_{init} = C(0 - VDD) = -C \cdot VDD$$

$$Q_{final} = C(VDD - 0) = C \cdot VDD$$

$$Q_{tot} = Q_{final} - Q_{init} = 2C VDD$$

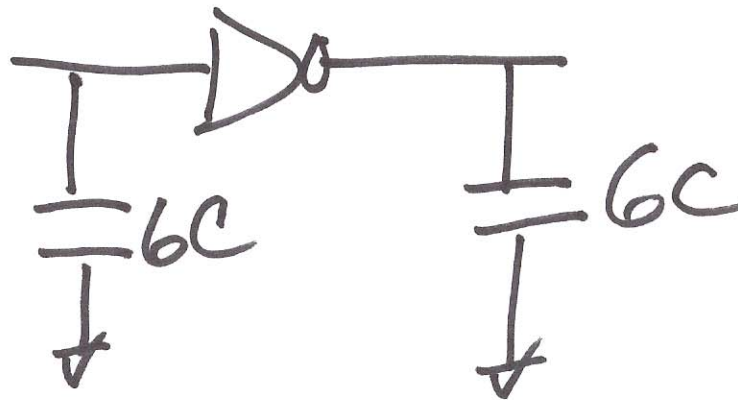
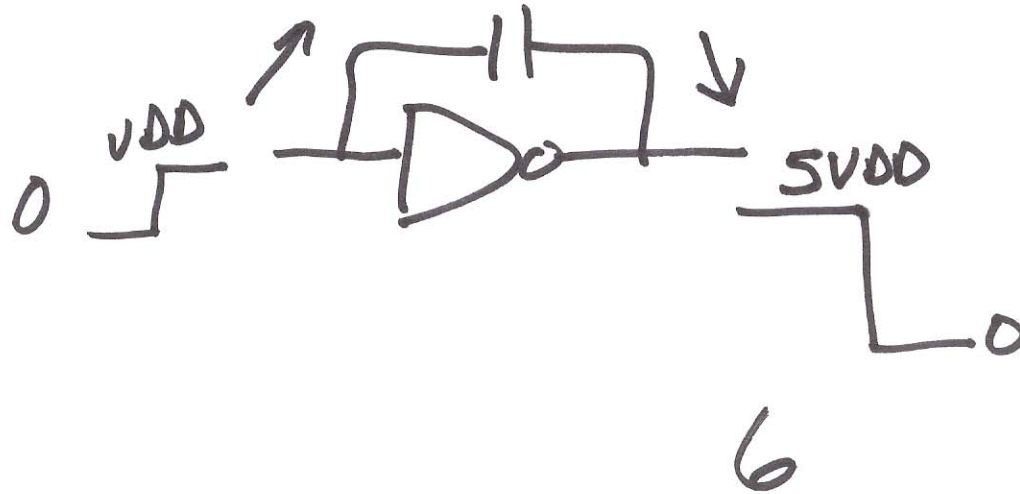


$$\frac{V_{IN} - V_{OUT}}{1/j\omega C} = \frac{V_{IN} + A \cdot V_{OUT}}{1/j\omega C}$$

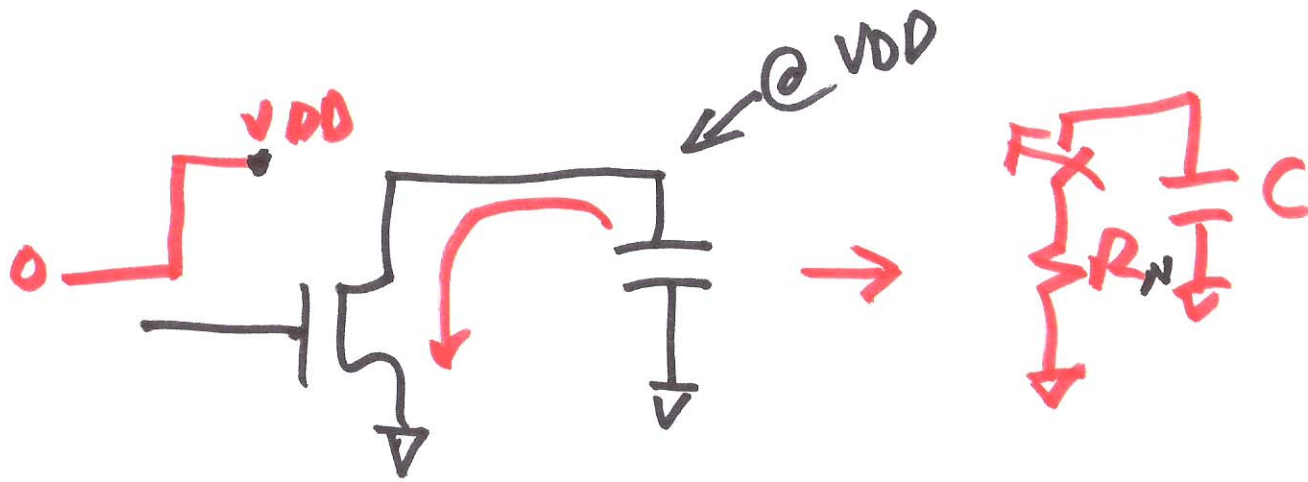
$$= \frac{V_{IN}}{1/j\omega C(1+A)}$$

2)

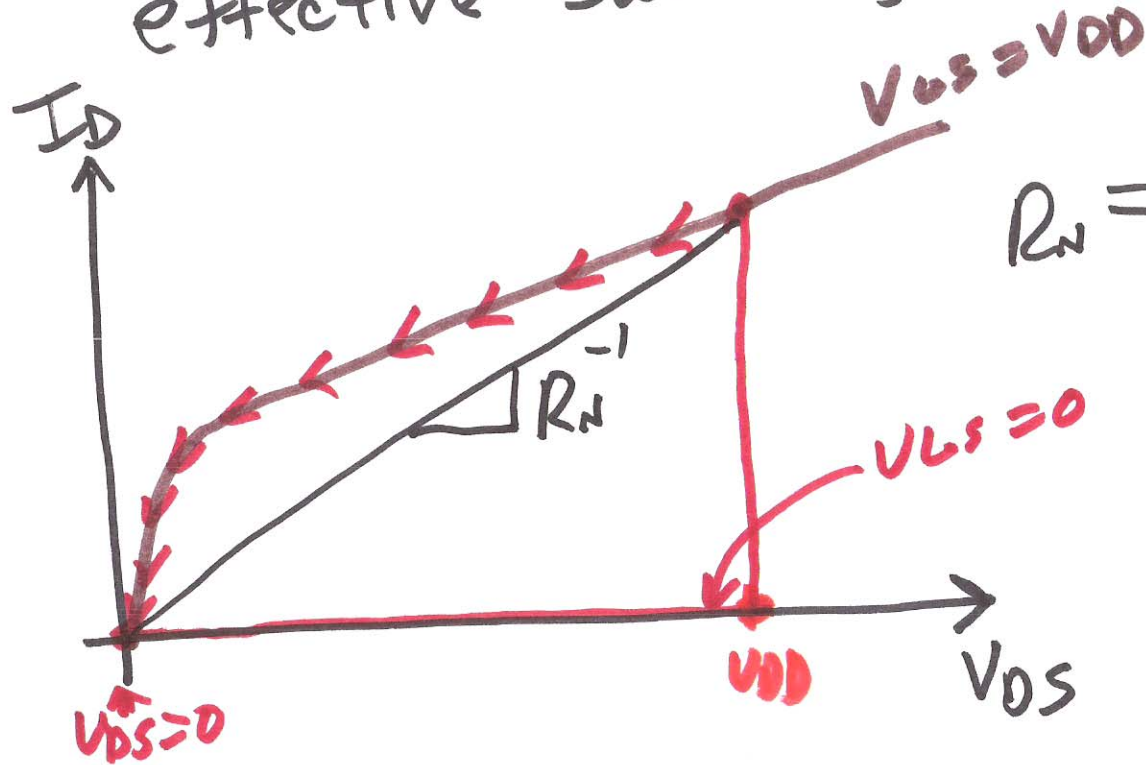
$$i = C \frac{dV}{dt}$$



3)



effective switching resistance



$$R_N = \frac{1}{\text{slope}}$$

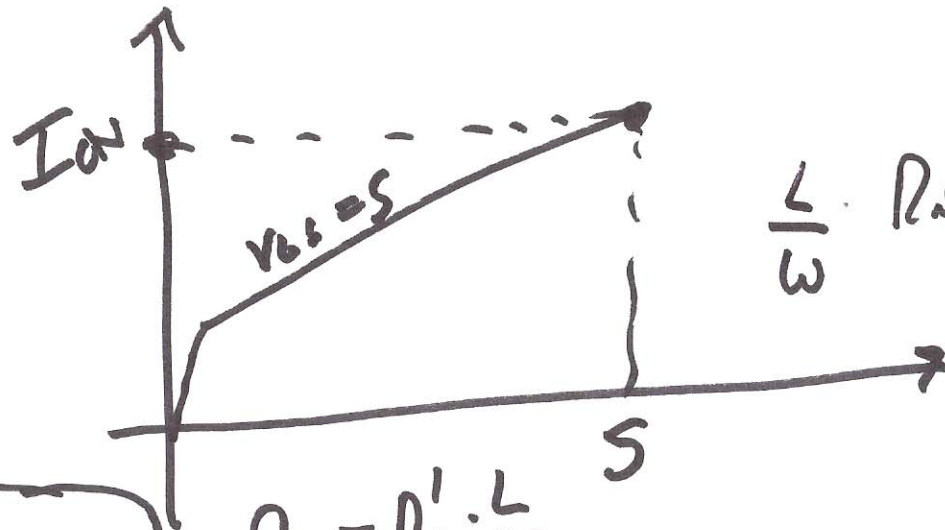
$$= \frac{V_{DD}}{\frac{\beta_N}{2} (V_{DD} - V_{TH})^2}$$

4)

$$R_N = \frac{V_{DD}}{\frac{K_{PN}}{2} \cdot \frac{W}{L} (V_{DD} - V_{THN})^2} = R_N' \cdot \frac{L}{W}$$

Long-channel process from book

$$R_N' = \frac{5}{\frac{120 \mu A}{V} \cdot \frac{1}{2} \cdot (5 - 0.8)^2} \approx \frac{5}{604 \cdot 16} \approx 5k??$$



$$\frac{L}{W} R_N' = \frac{5}{I_{DN}} = 5k\Omega$$

$$R_N' = \frac{5}{I_{DN}} \cdot \frac{L}{W}$$

$$15k = R_N' = \frac{5}{3.3mA \cdot \frac{1}{10}}$$

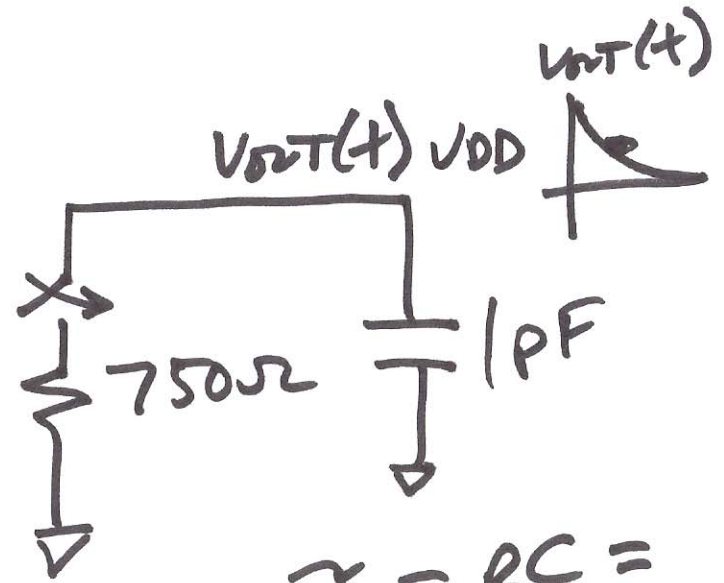
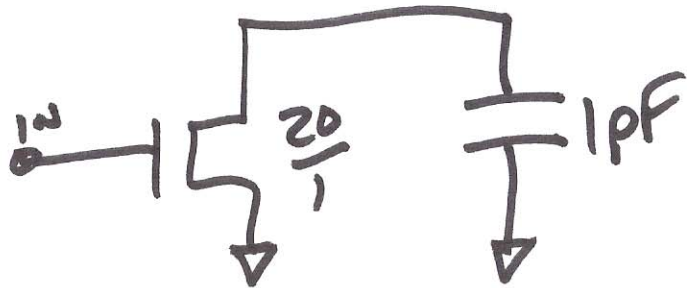
$$R_P = R_P' \cdot \frac{L}{W}$$

$$R_N' = 15k$$

$$R_P' = 45k$$

5)

$$R'_N = 15\text{K}$$



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

$$R_N = \frac{15\text{K}}{20} = 750\Omega$$

$$\tau = RC = 750\text{ps}$$

delay

50%

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

$$V_{out}(t) = V_{DD} e^{-t/RC}$$

$$\frac{V_{DD}}{2} = V_{DD} e^{-t_{delay}/RC}$$

$$t_{delay} = 0.7 RC$$

~~$$t_{delay} = RC$$~~

b)

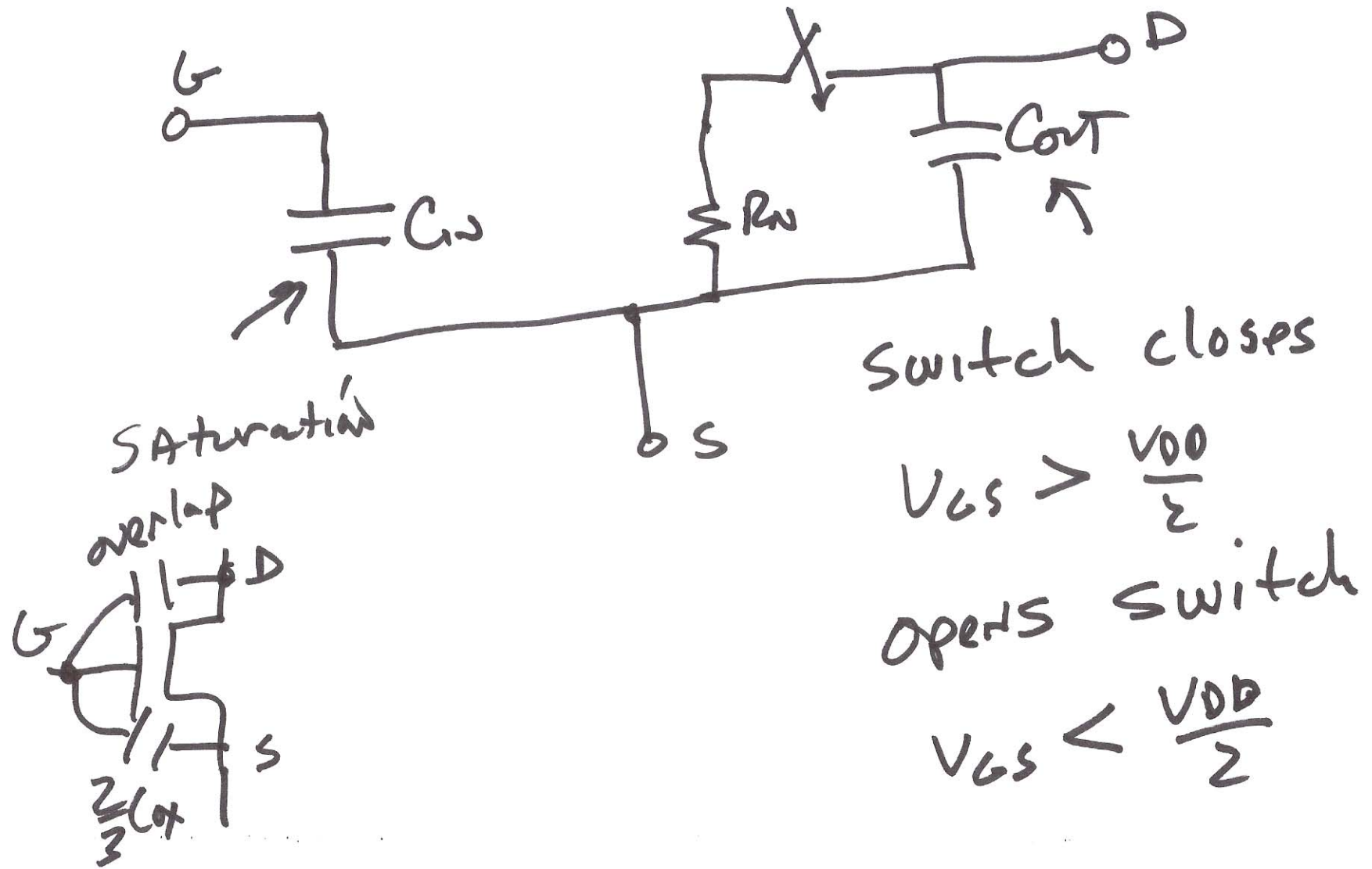
Short channel MOSFET
(50nm process)
 R'_n & R'_p

$$R_n = \frac{V_{DD}}{I_{drive,n}} = 34k \cdot \frac{L}{W}$$

$$R_p = \frac{V_{DD}}{I_{drive,p}} = 68k \cdot \frac{L}{W}$$

$$R'_n = 34k \quad \& \quad R'_p = 68k$$

50nm process



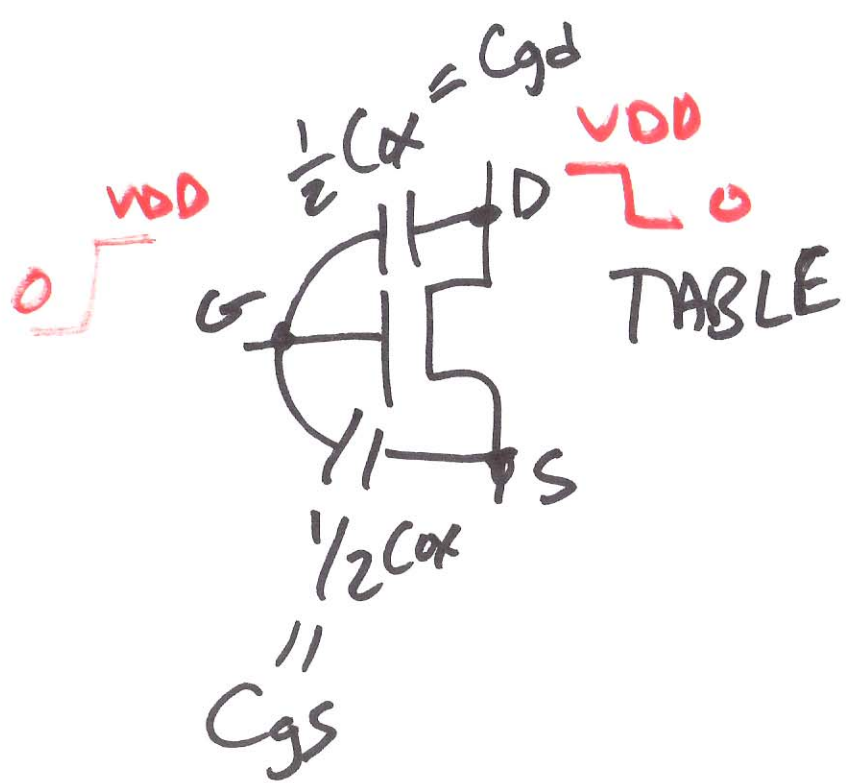
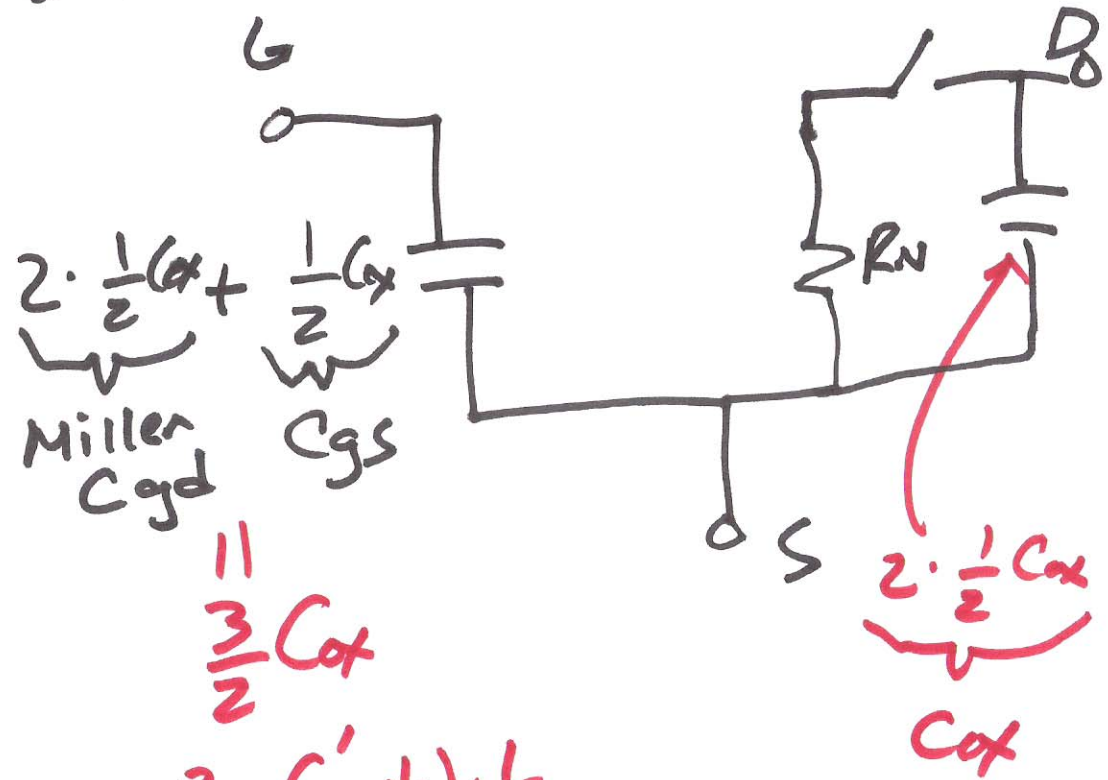


TABLE 6.1



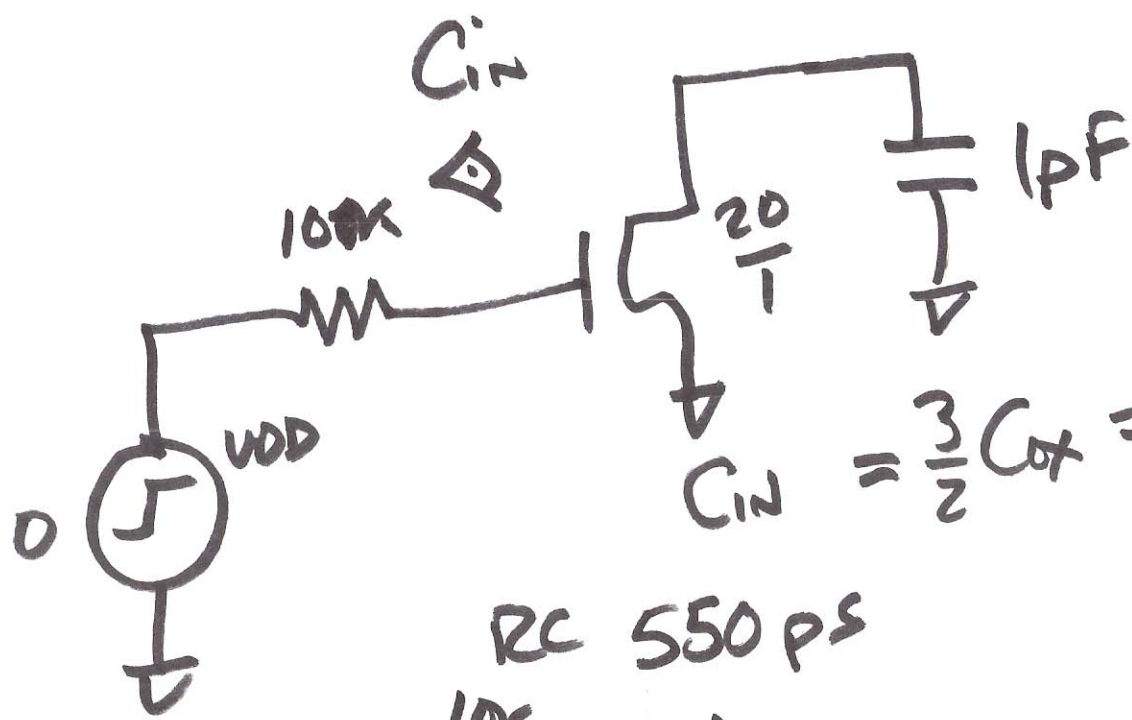
$$\frac{3}{2} C_{ox}$$

$$\frac{3}{2} \cdot C'_{ox} \cdot W \cdot L$$

$$\frac{3}{2} \cdot \frac{\epsilon_{ox}}{t_{ox}} \cdot W \cdot L$$

9)

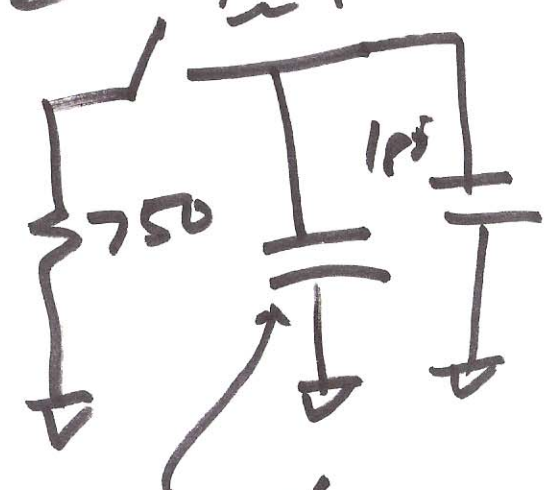
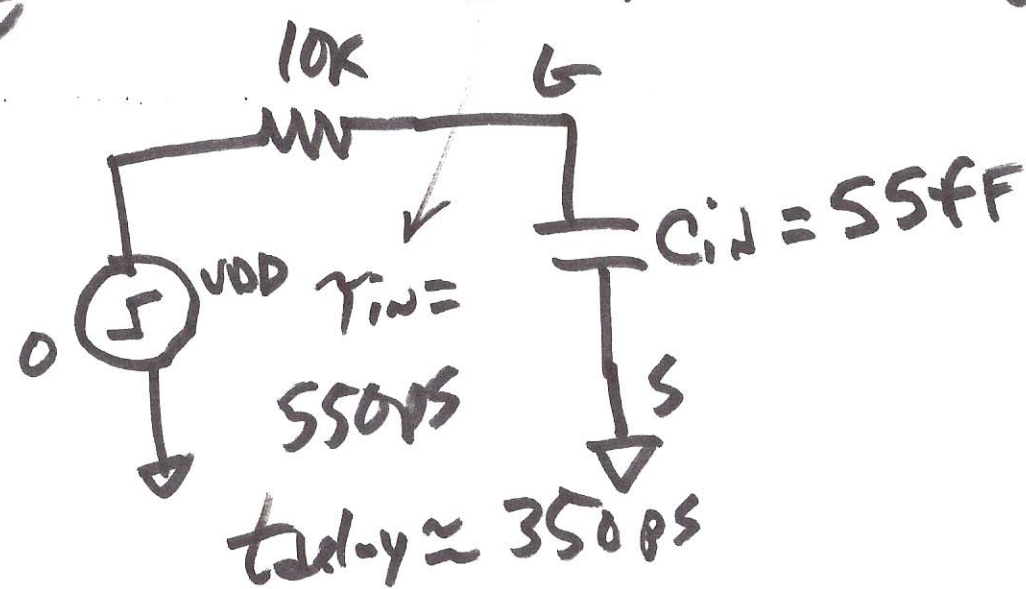
$$C_{ox}' = 1.75 \text{ fF}/\mu\text{m}^2$$



$$C_{in} = \frac{3}{2} C_{ox}' = \frac{3}{2} \cdot 20 \cdot 1 \cdot 1.75 \text{ fF} \approx 55 \text{ fF}$$

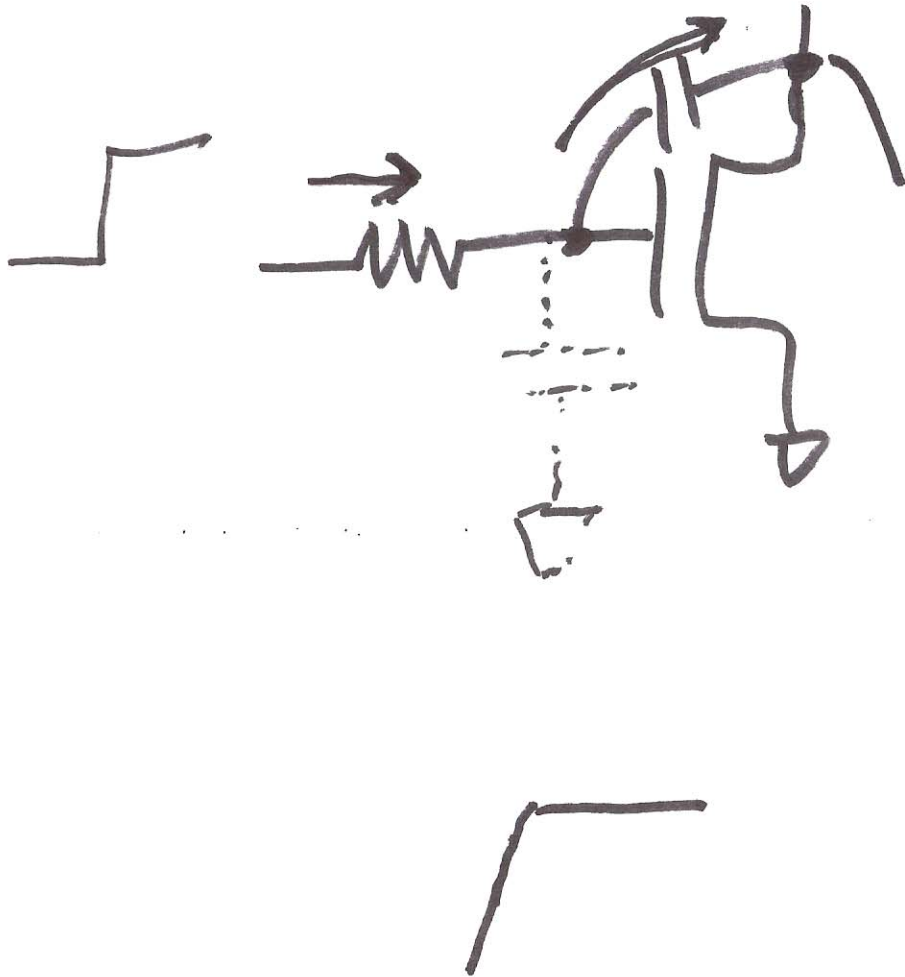
RC 550 ps

$$t_d = 500 \text{ ps} \approx 750 \text{ ps}$$



$$C_{out} = C_{ox}' \cdot W \cdot L \approx 36 \text{ fF}$$

10)



ii)