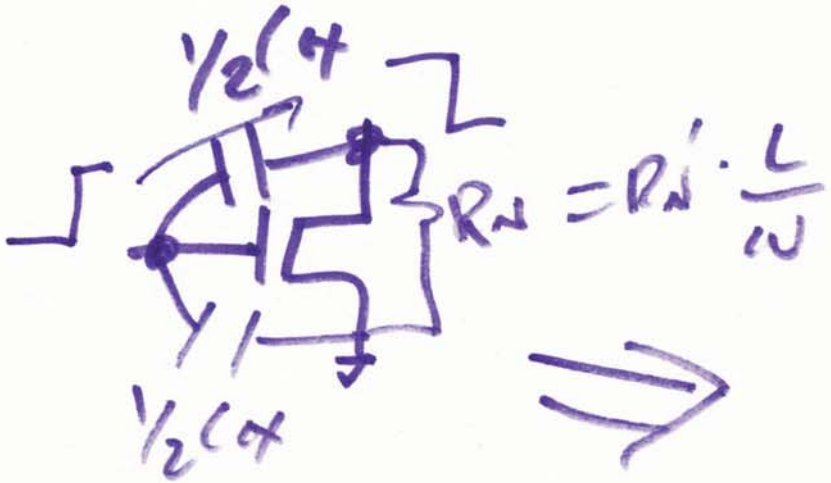
Lecture 20

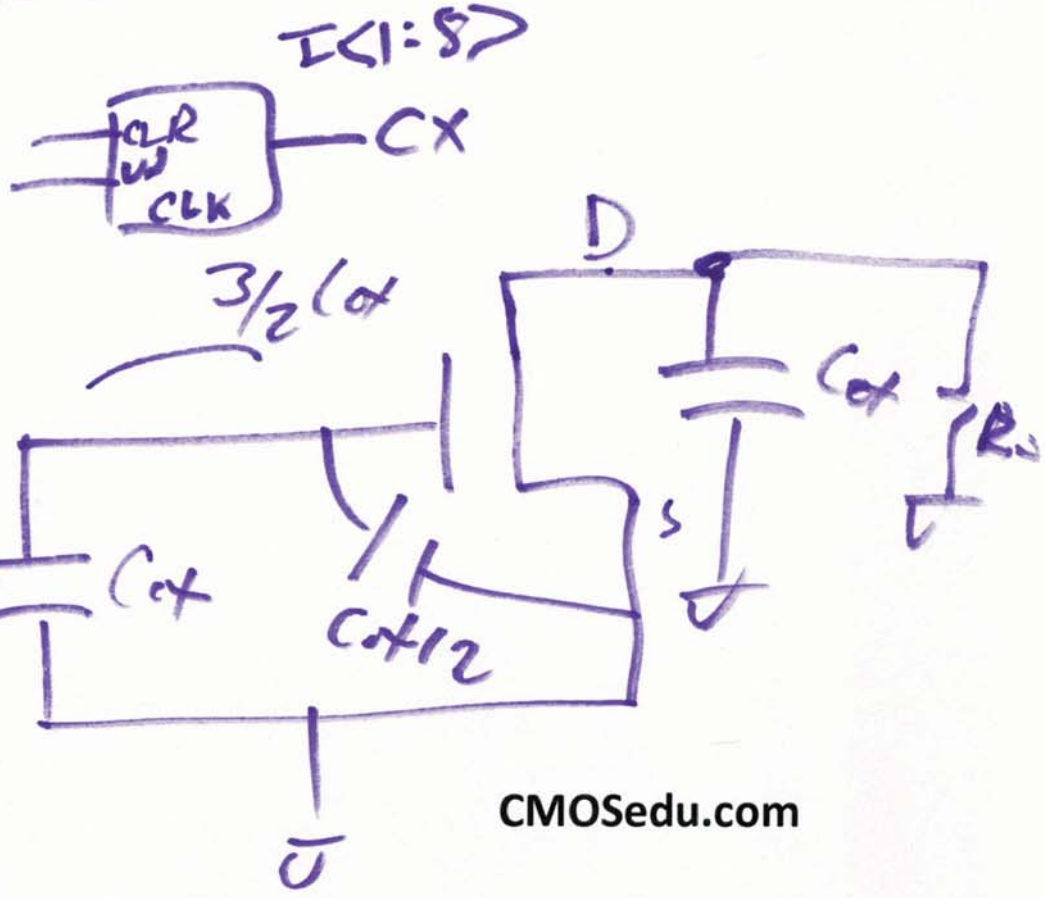
Nov. 4, 2015

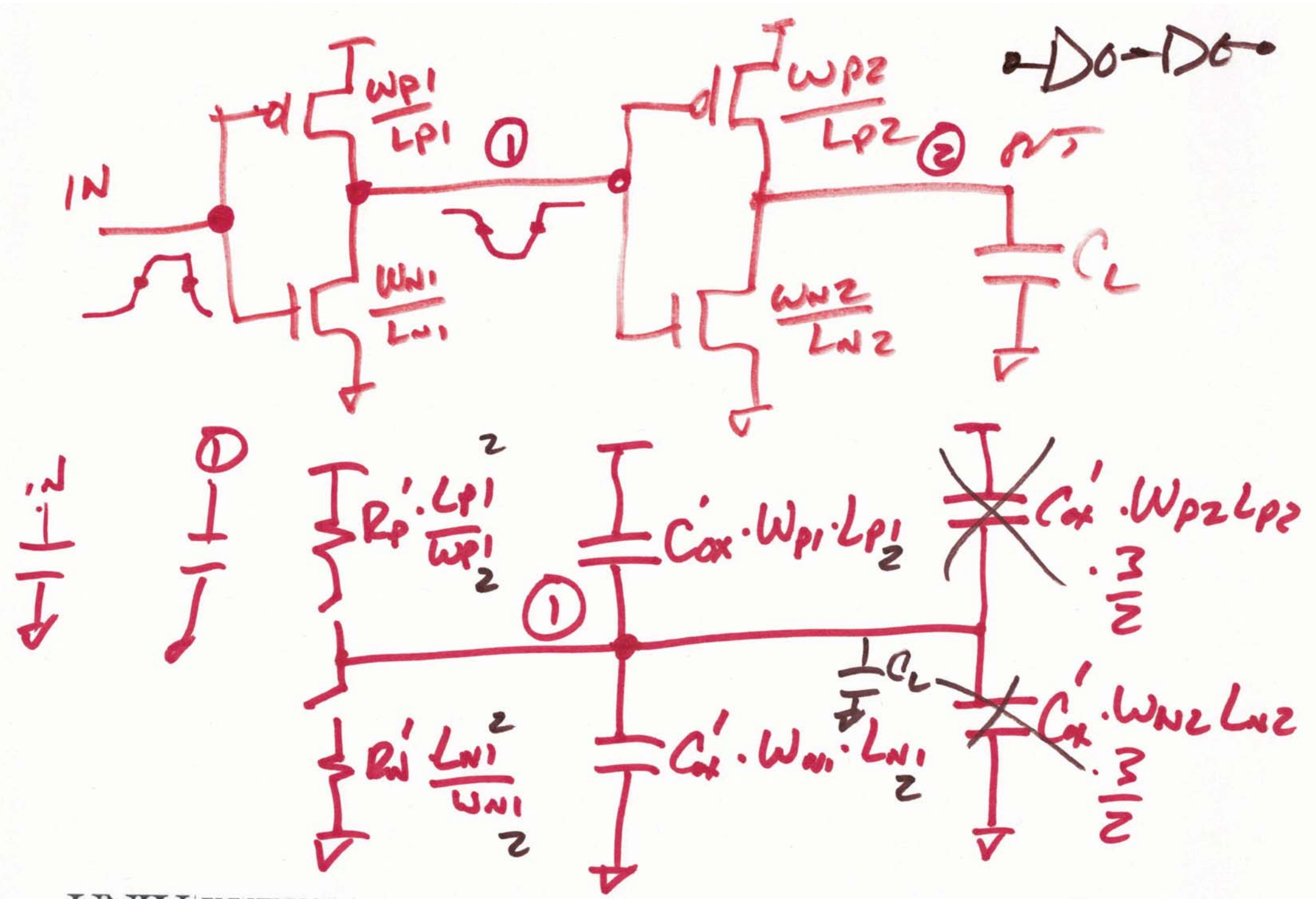
EE 421/ECG 621

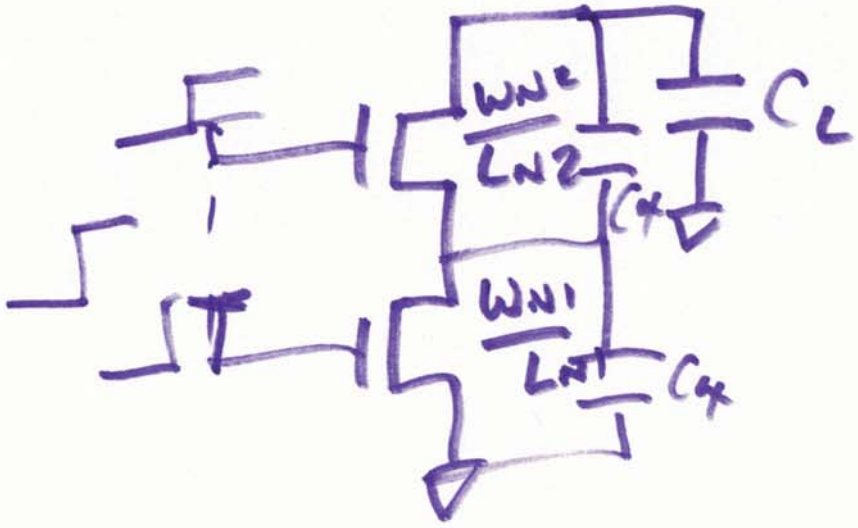
Digital IC Design

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






IN
W_{P1}/L_{P1}
W_{N1}/L_{N1}
①
W_{P2}/L_{P2}
W_{N2}/L_{N2}
②
OUT
C_L
DO
$R_P' \cdot L_{P1}/W_{P1}^2$
$C_{ox}' \cdot W_{P1} \cdot L_{P1}^2$
$C_{ox}' \cdot W_{P2} L_{P2} \cdot 3/2$
$R_N' L_{N1}^2/W_{N1}^2$
$C_{ox}' \cdot W_{N1} \cdot L_{N1}^2$
$C_{ox}' \cdot W_{N2} L_{N2} \cdot 3/2$



ASSUME $C_L \gg C_{ox} \cdot W_{N2} L_{N2}$ OR $C_{ox} W_{N1} L_{N1}$

$$t_{PHL} = 0.7 (R_{N1} + R_{N2}) C_L$$

$$0.7 (R_{N1} + R_{N2}) \cdot$$

$$C_L + \cancel{C_{ox}}$$

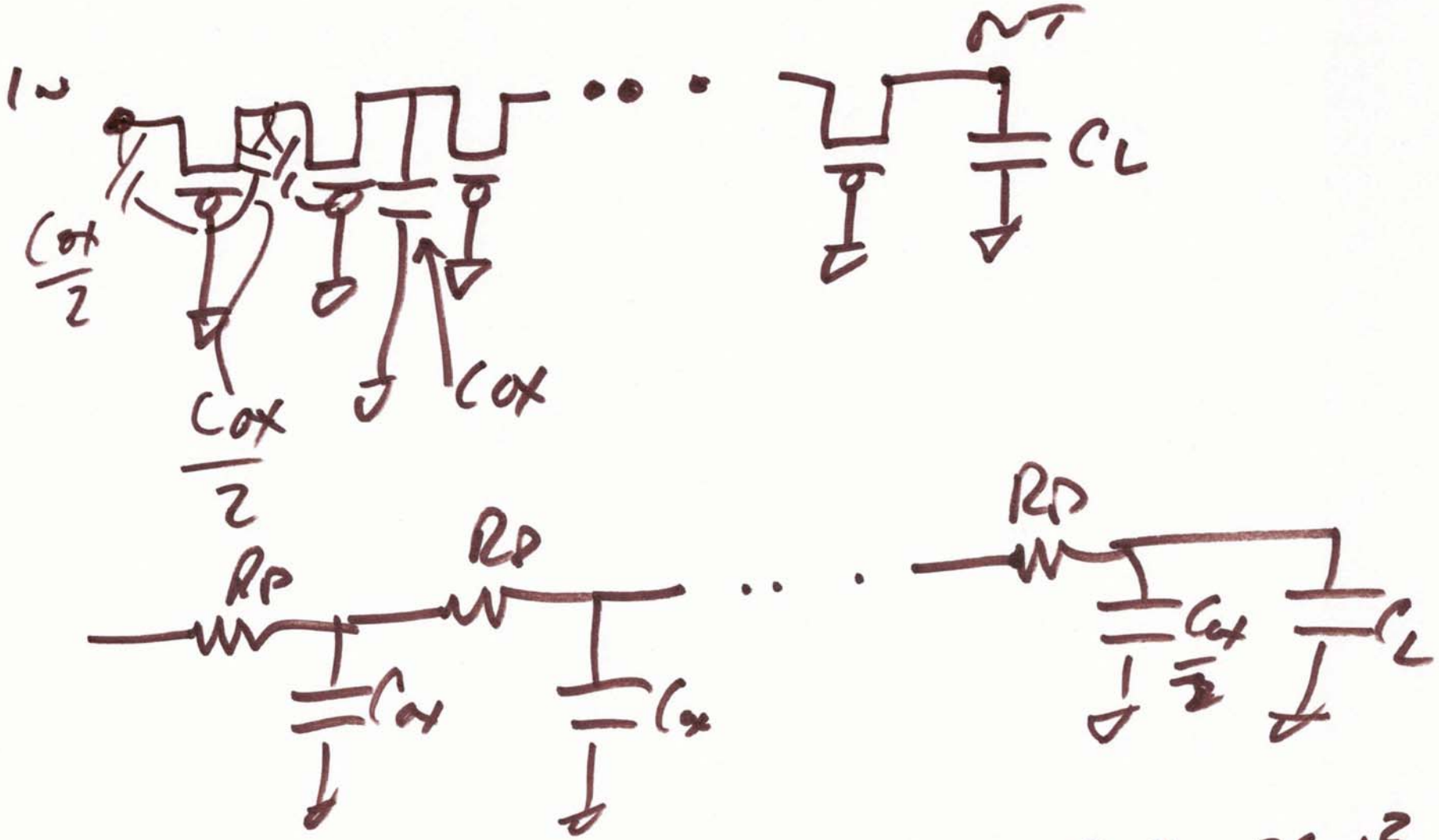
$$C_{ox}' \cdot W_{N2} L_{N2}$$

$$\cdot C_{ox}' W_{N1}$$

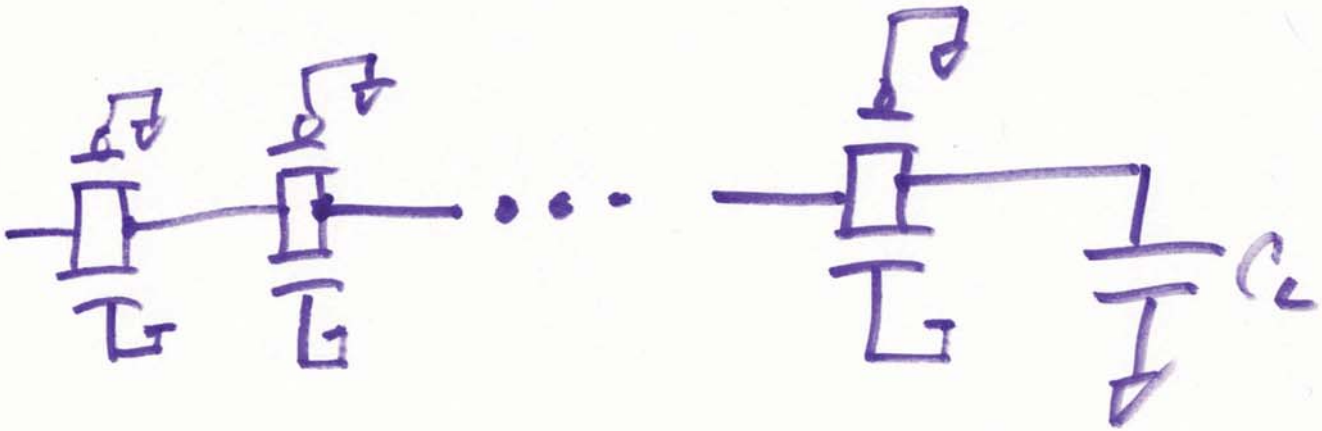
$$\cdot L_{N1}$$

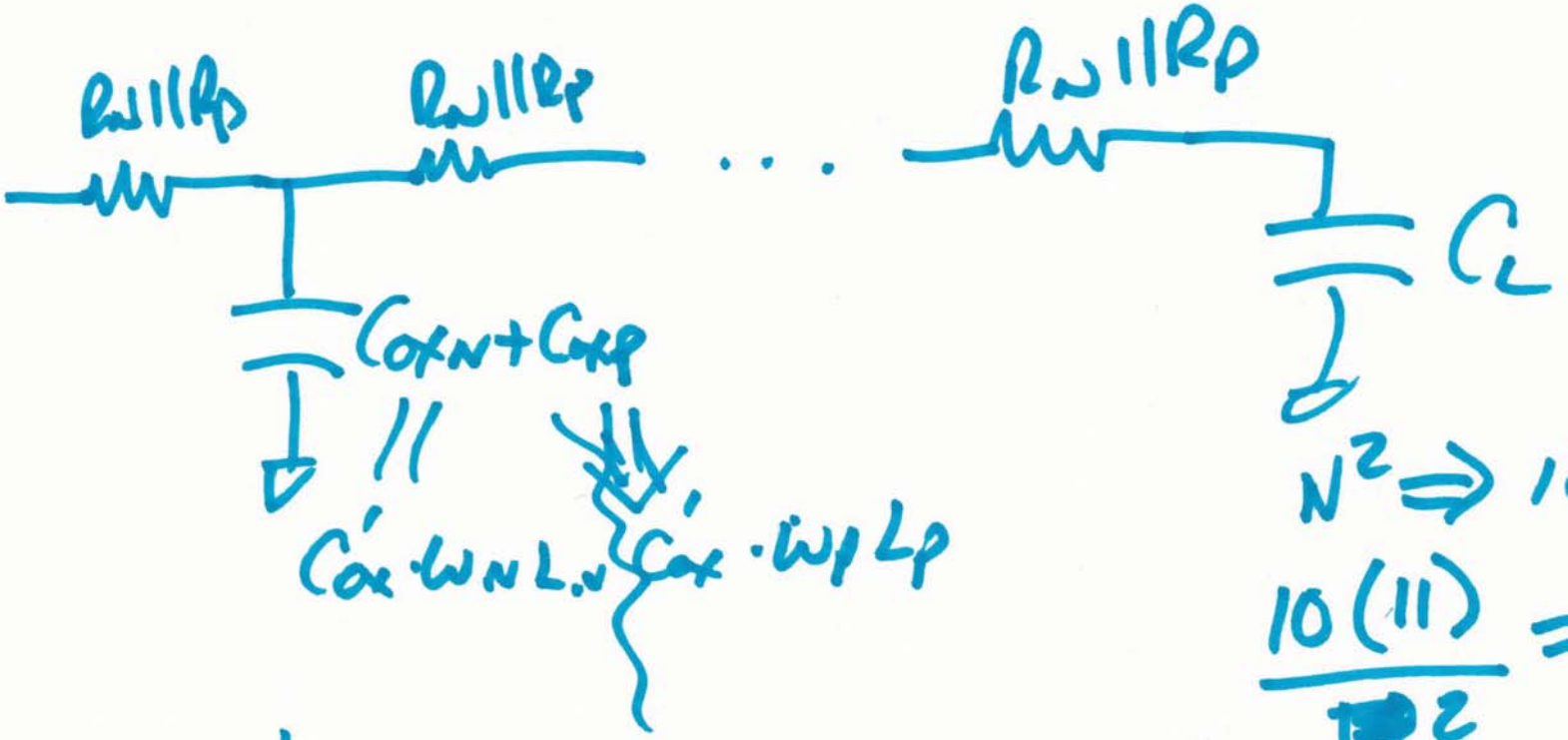
$$C_{ox}' \cdot W_{N2} L_{N2} + C_{ox}' W_{N1}$$

$$L_{N1}$$



$$t_d = 0.7 N R_p \cdot C_L + R_p \cdot C_{ox} \cdot .35 N^2 + 0.7 \cdot R_p \cdot C_{ox} \cdot \frac{N(N+1)}{2}$$

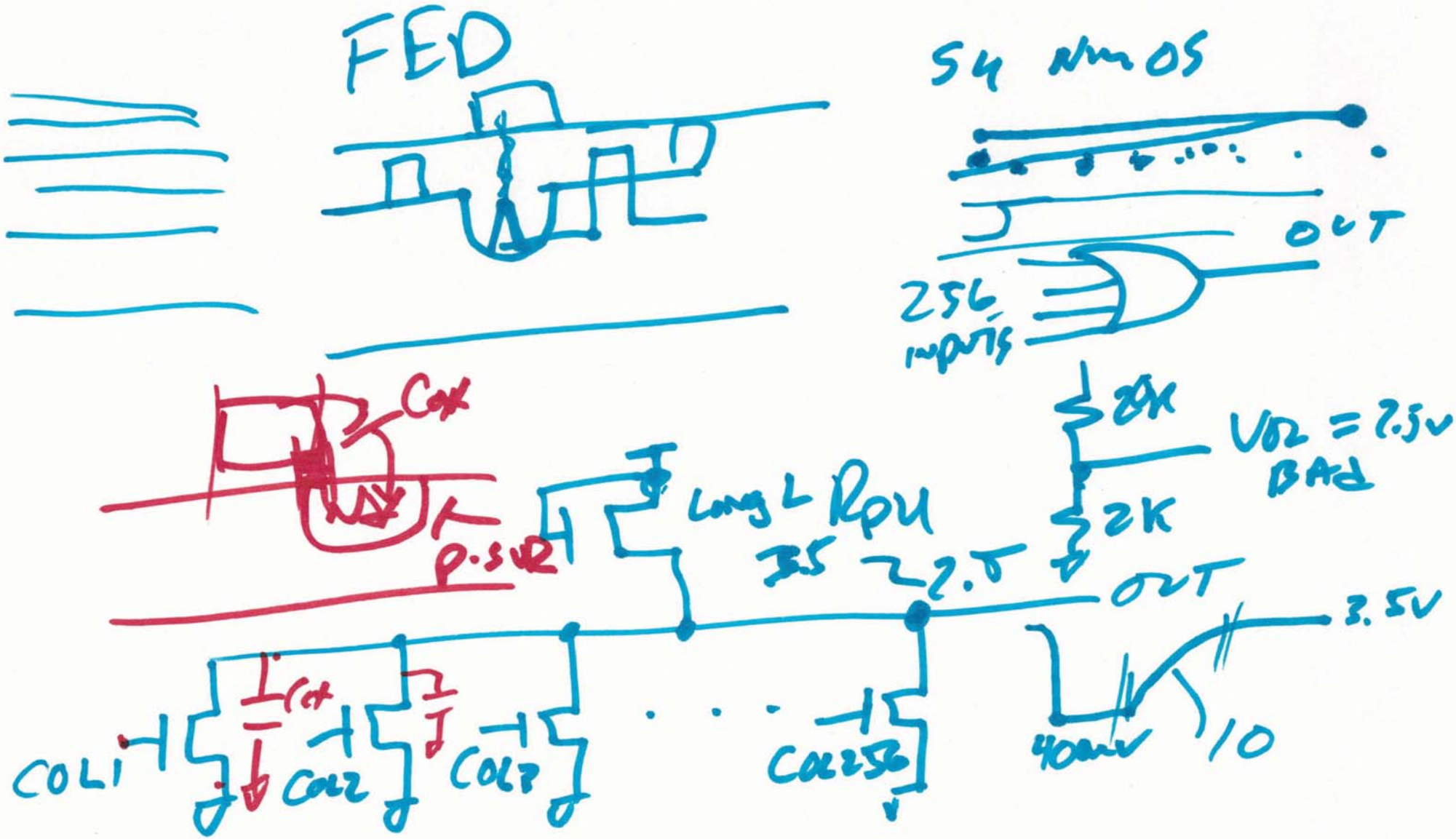




$N^2 \Rightarrow 100 \cdot .35$

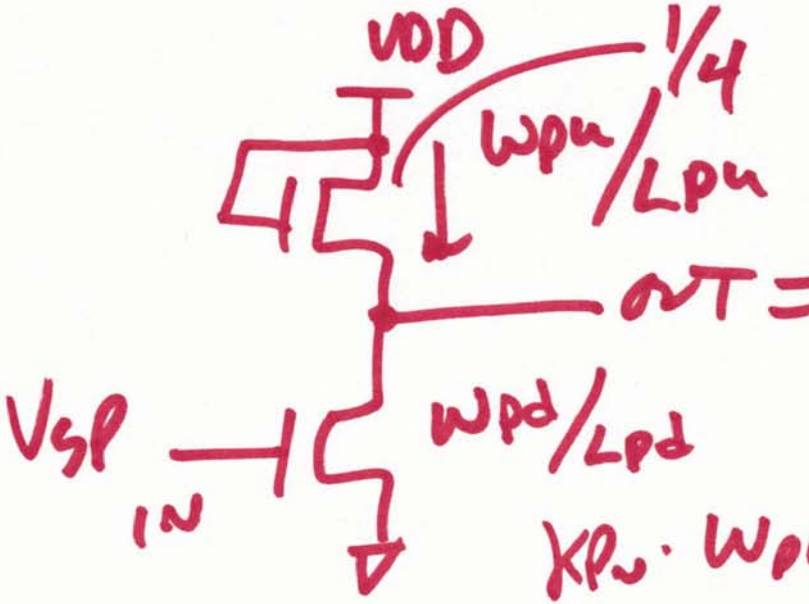
$\frac{10(11)}{2} = 55.7$

$$t_d = 0.7N \cdot R_N \| R_P \cdot C_L + 0.35 R_N \| R_P \cdot ((C_{oxN} + C_{oxP})N^2$$



$$t_{PHL} = R_N \cdot 256 \cdot C_{ox}$$

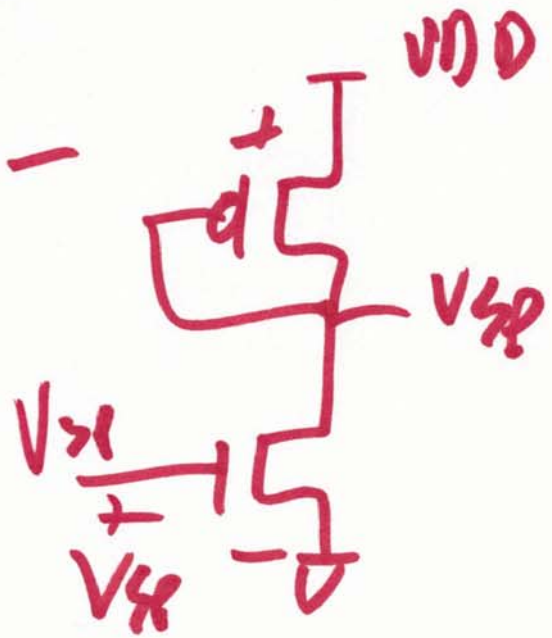
$$R_{PU} \cdot 256 \cdot C_{ox}$$



$$\frac{K_n}{2}\cdot\frac{W_{pu}}{L_{pu}}\cdot\left(V_{DD}-V_{sp}-V_{Tn}\right)^2$$

$$=\frac{K_n}{2}\frac{W_{pd}}{L_{pd}}\cdot\left(V_{sp}-V_{Tn}\right)^2$$

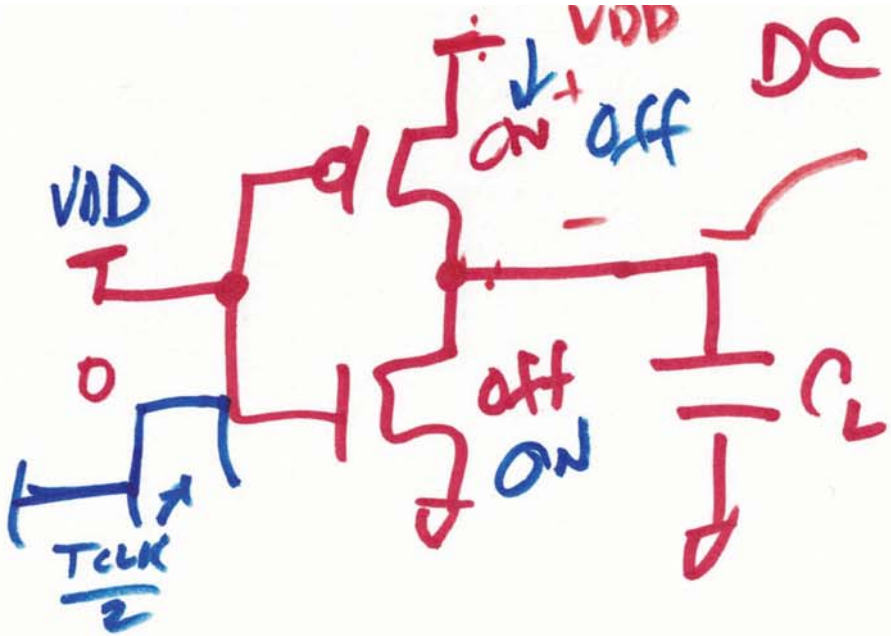
7)



$$\frac{K_P}{2}\cdot\frac{W_P}{L_P}\left(V_{DD}-V_{SI}-V_{THP}\right)^2$$

$$=\frac{K_N}{2}\frac{W_N}{L_N}\left(V_{SD}-V_{THN}\right)^2$$

$$V_{DD}-V_{THN}$$



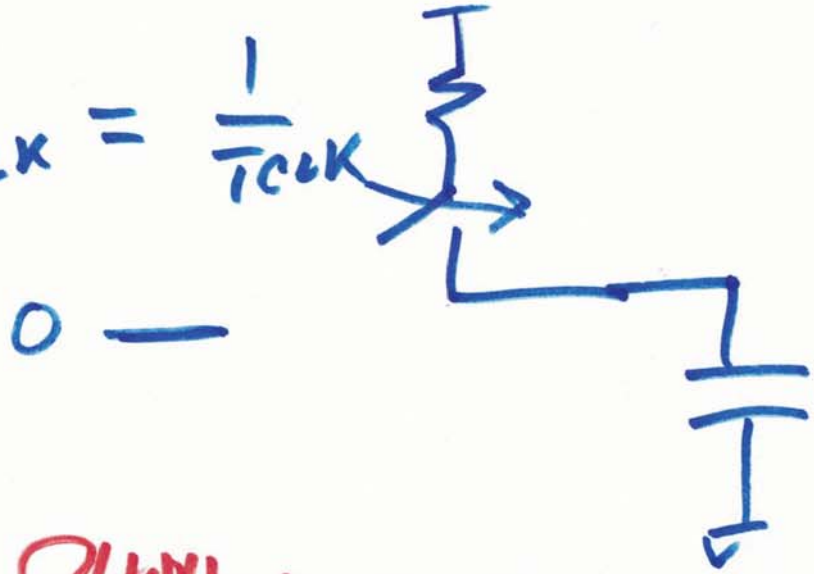
IN	power
0	$V_{DD} \cdot I_{offN}$
VDD	$V_{DD} \cdot I_{offp}$

$$\Rightarrow \frac{1}{2} C_L V_{DD}^2$$

$$Q = CV = C_{TOT} \cdot V_{DD}$$

$$I_{AVG} = \frac{C_{TOT} \cdot V_{DD}}{T_{CLK}/2}$$

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



$$Power = V_{DD} \cdot I_{AVG}$$

$$Power = \frac{C_{TOT} \cdot V_{DD}^2 \cdot f_{CLK}}{2}$$

$$P_{dynamic} = C_{TOT} \cdot V_{DD}^2 \cdot f_{CLK}$$