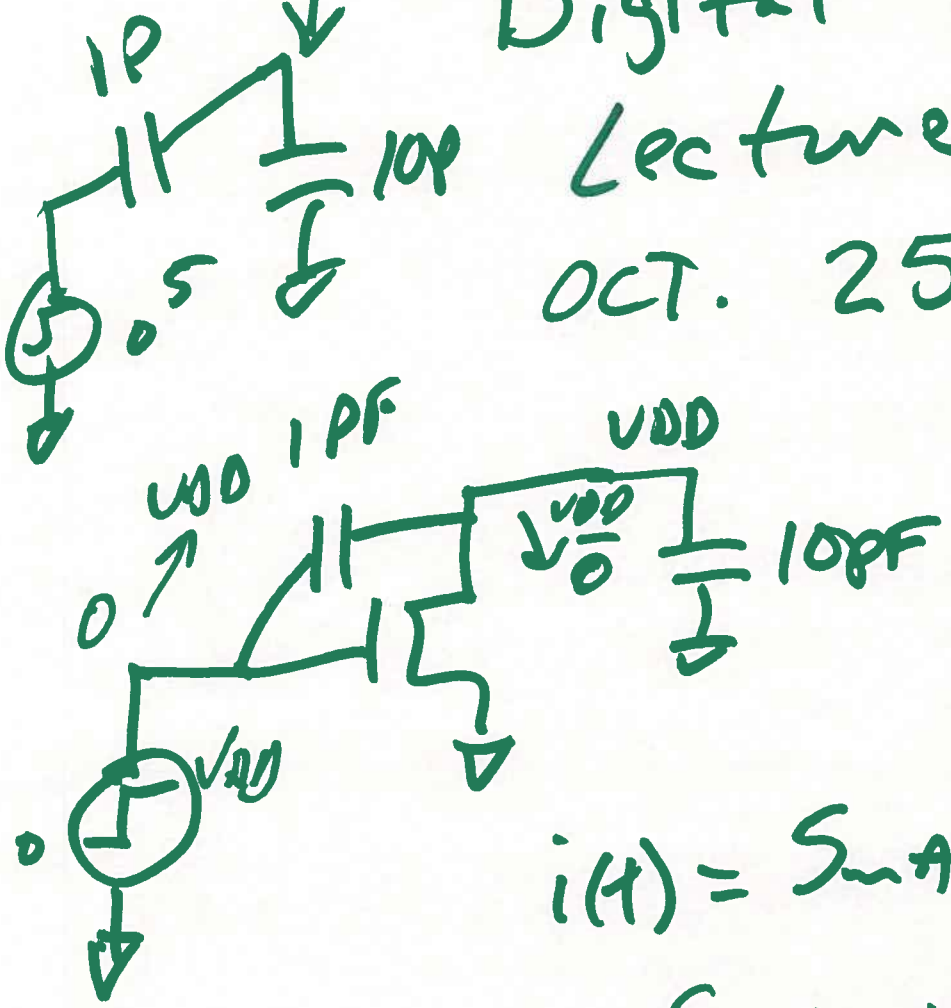
# EE 421/ECG 621
# Digital IC Design
## Lecture 16
## OCT. 25, 2017




$Q = 1pF \cdot 2VDD$

$VDD = 5V$

$Q = 10pC$

$i(t) = 5mA \cdot e^{-t/1ns}$

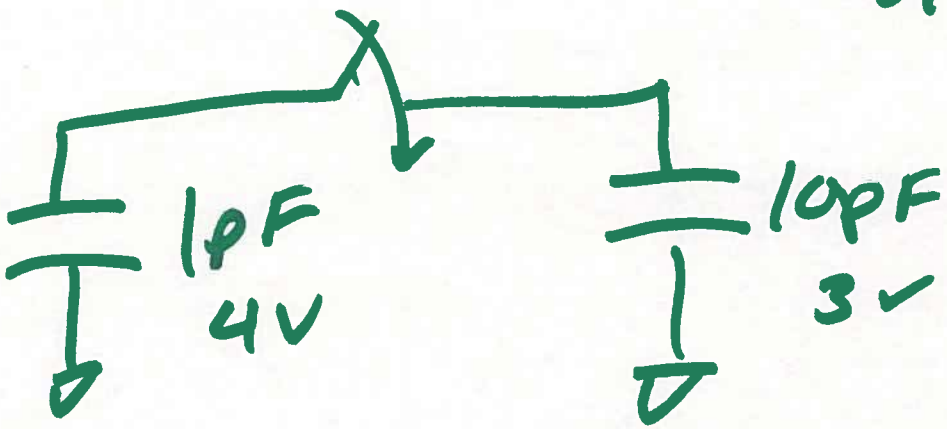
$V = \frac{-t}{1ns}$

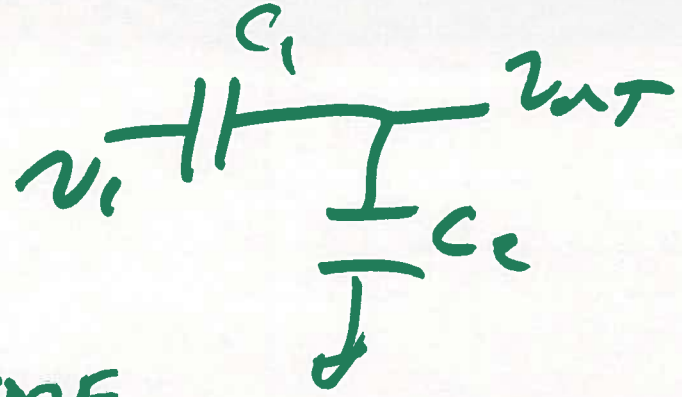
$du = \frac{-1}{1ns} \cdot dt$

$Q_{TOT} = \int i(t) \cdot dt = -5mA \cdot 1ns \int e^{-t/1ns} \; 0 \to \infty$

$\int e^u \cdot du$ = 5pC

$CV = Q$



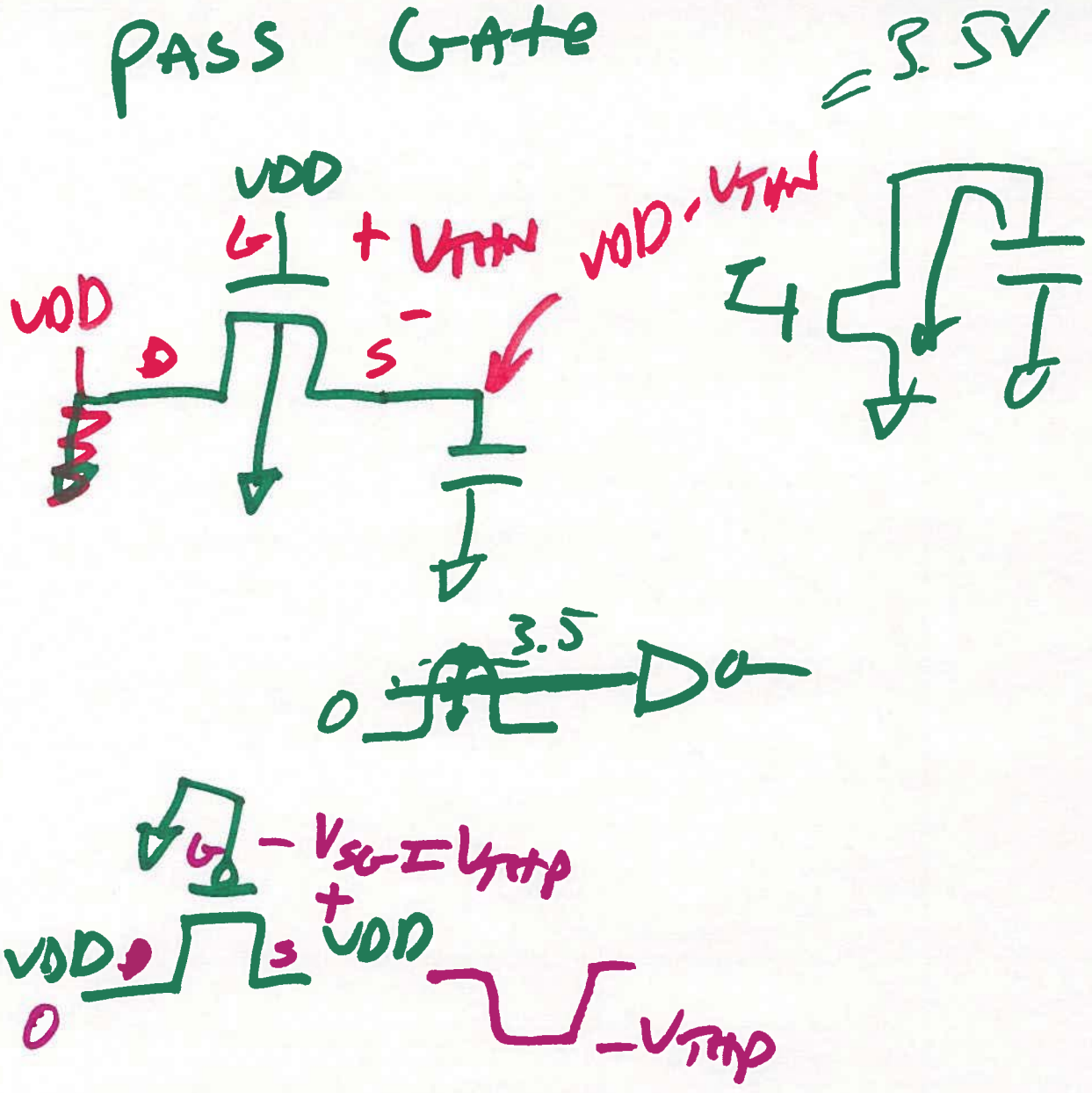




$$4 \cdot 1pF + 3 \cdot 10pF = 34pC = 11pF \cdot V_F$$

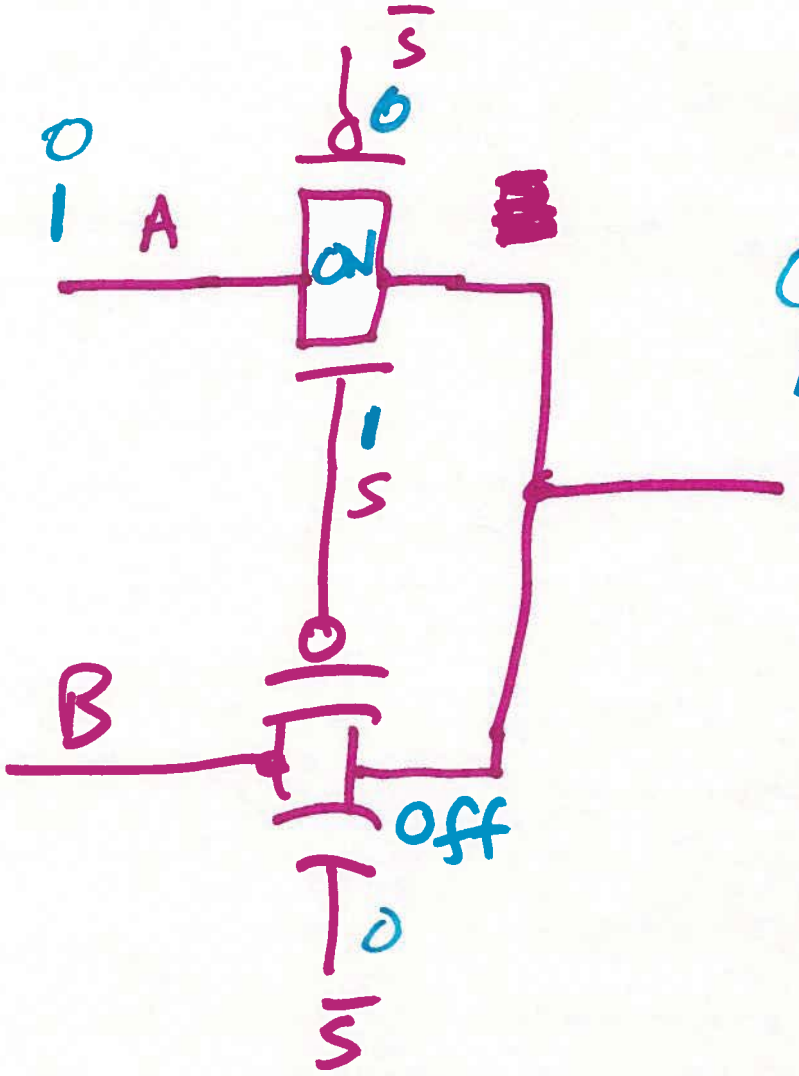
$$V_F = \frac{34pC}{11pF} \simeq \underline{3.1V}$$

$$2nT = V_1 \cdot \frac{\frac{1}{j\omega C_2}}{\frac{1}{j\omega C_1} + \frac{1}{j\omega 1_1}} = V_1 \cdot \frac{C_1}{C_1 + C_2}$$

# Pass Gate

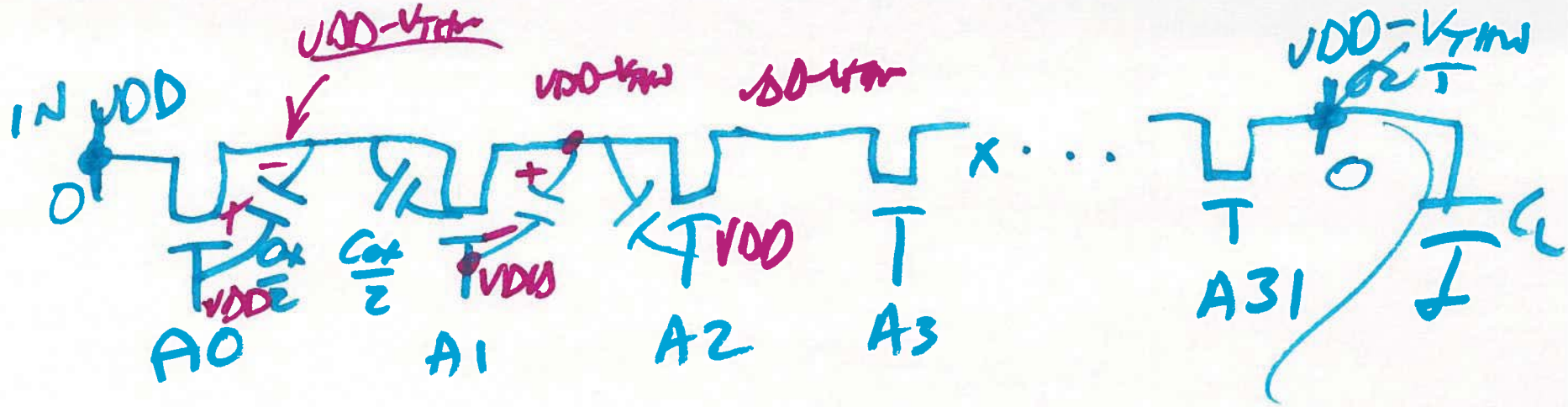


# TRANSMISSION GATE TG

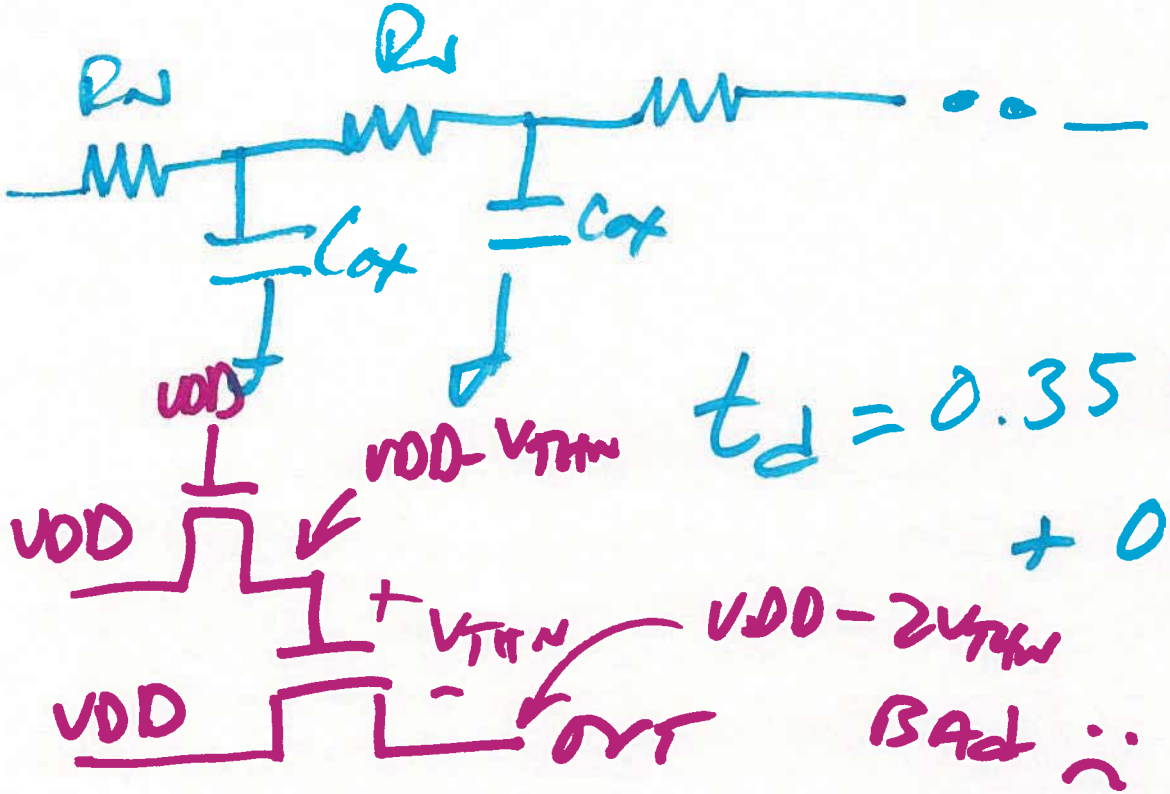



$Z = A \cdot S + B \cdot \overline{S}$

2 to 1 MUX

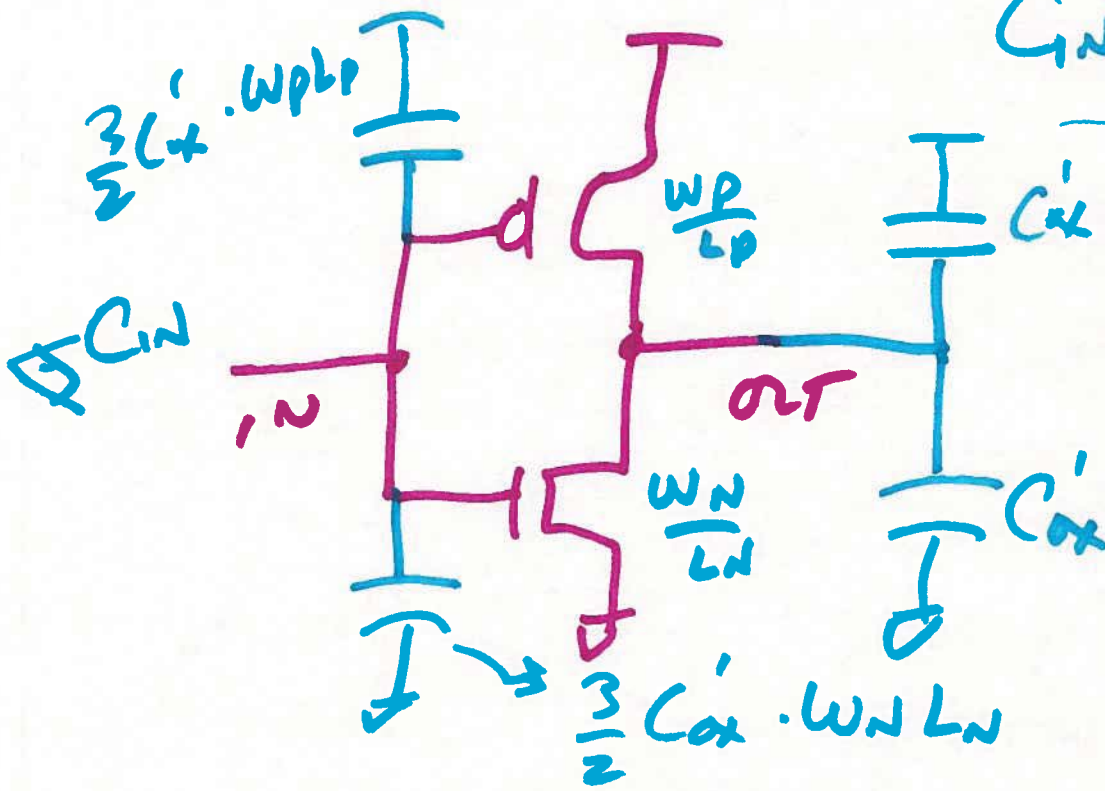



$$t_{pHL} = 32R_N \cdot C_L \cdot 2.2$$




$$t_d = 0.35 \cdot R_N \cdot C_{ox} \cdot 32^2 + 0.7 \cdot 32R_N \cdot C_L$$

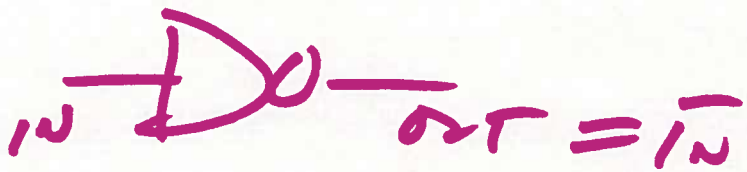
# Inverter

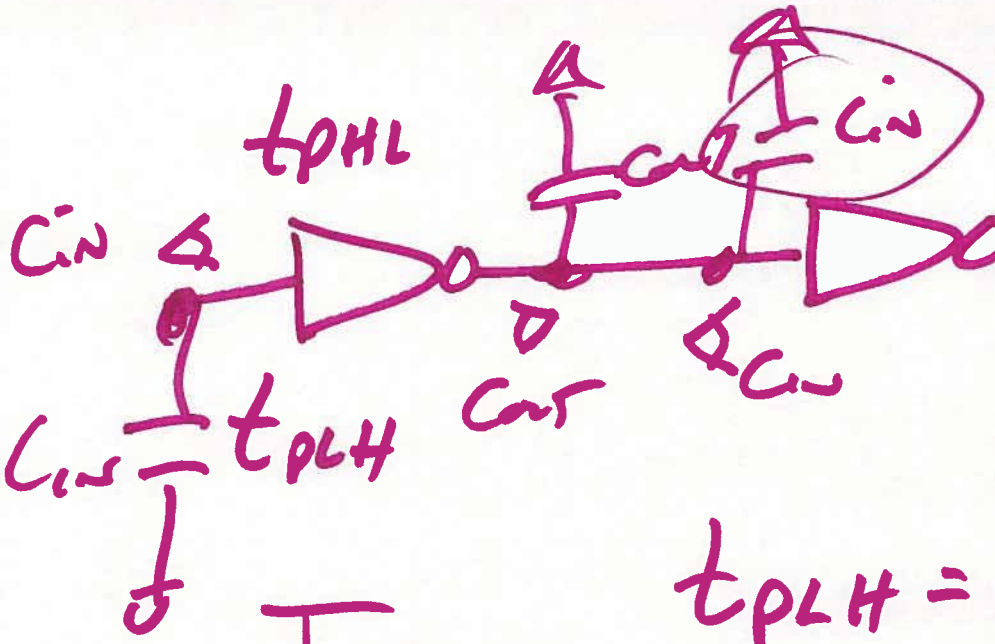


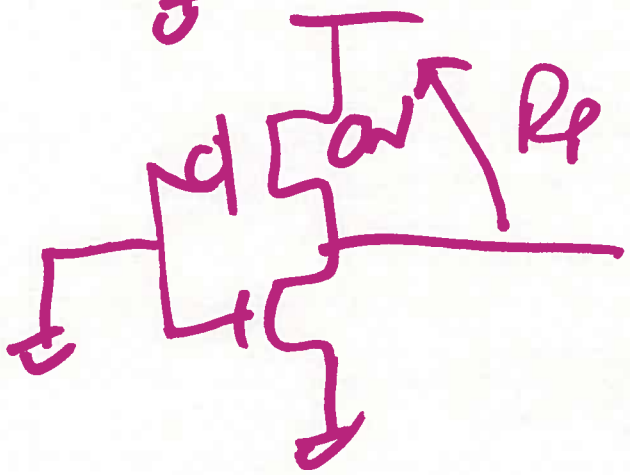

$$C_{IN} = \frac{3}{2} C_{ox}' (W_N L_N + W_P L_P)$$

$$C_{OUT} = C_{ox}' \cdot (W_N L_N + W_P L_P)$$

$$C_{IN} = \frac{3}{2} C_{OUT}$$






$$t_{pLH} = 0.7 R_p (C_{out} + C_{in}) =$$

$$= 0.7 R_p \left( C_{ox}' \cdot (W_N L_N + W_p L_p) \right.$$

$$\left. + \frac{3}{2} C_{ox}' (W_N L_N + W_p L_p) \right)$$

7.6)