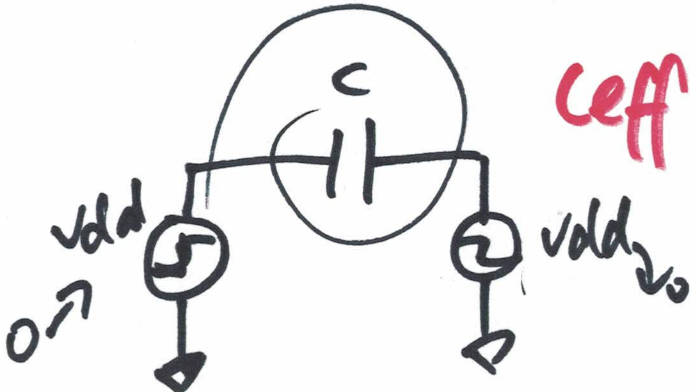


$C_{eff} = 2C$

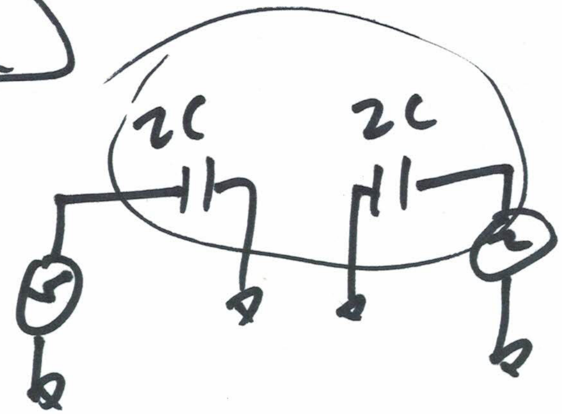
$\frac{Q}{C \mid V}$

$Q = CV.$

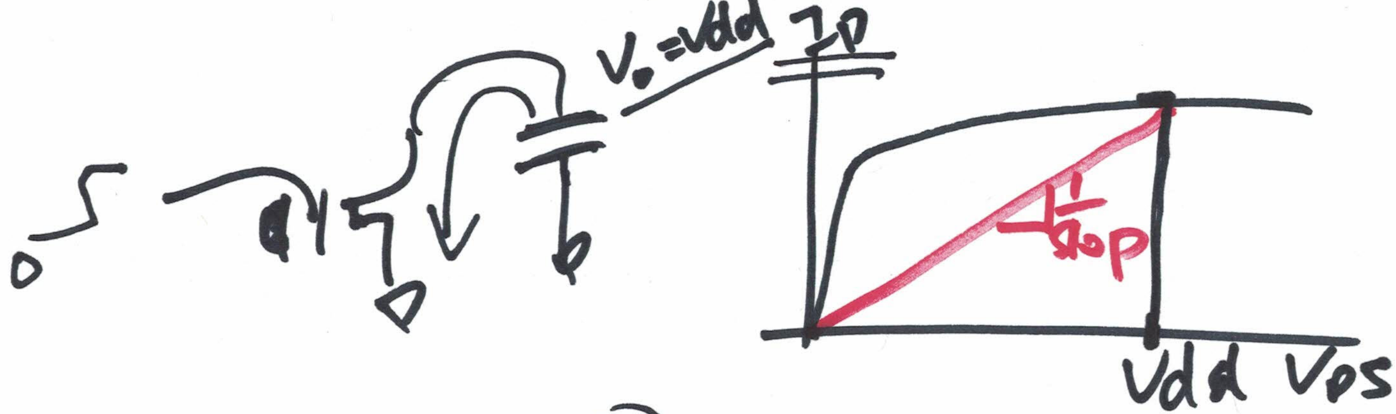
$\Delta Q = V_{dd} \cdot C_{eff} = 2Q$

$C \cdot V_{dd} = Q$

$C_{eff} = 2C$

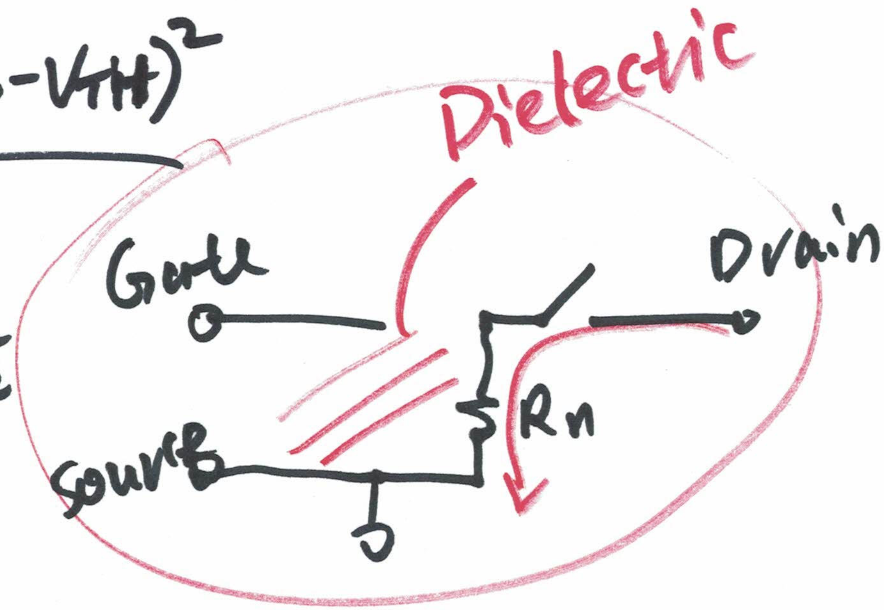


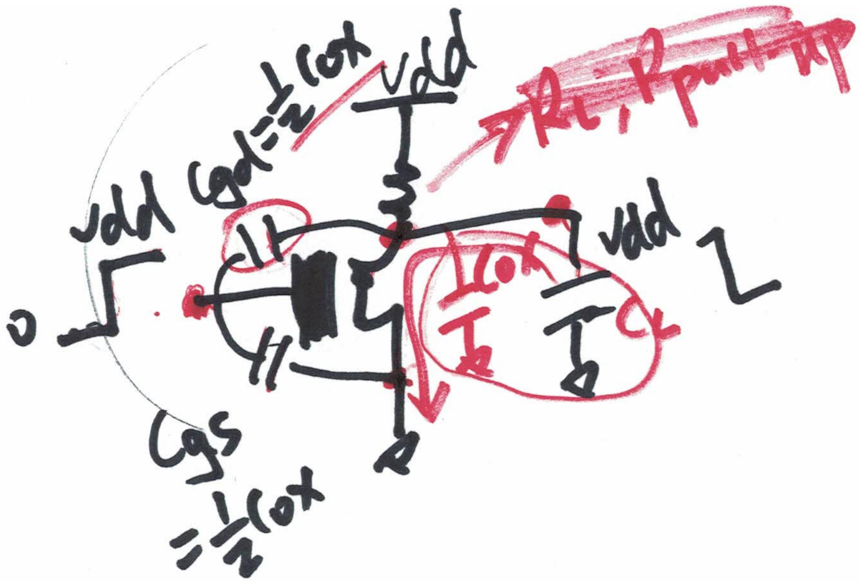
Miller Effect

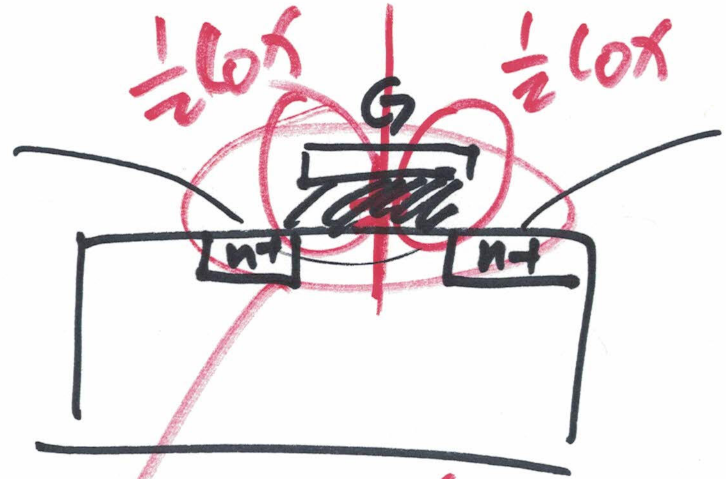


$$slope = \frac{I_D}{V_{dd}} = \frac{\frac{KP_n}{2}\frac{W}{L}(V_{GS}-V_{TH})^2}{V_{dd}}$$

$$R_n = \frac{1}{slope} = \frac{V_{dd}}{\frac{KP_n}{2}\frac{W}{L}(V_{GS}-V_{TH})^2}$$

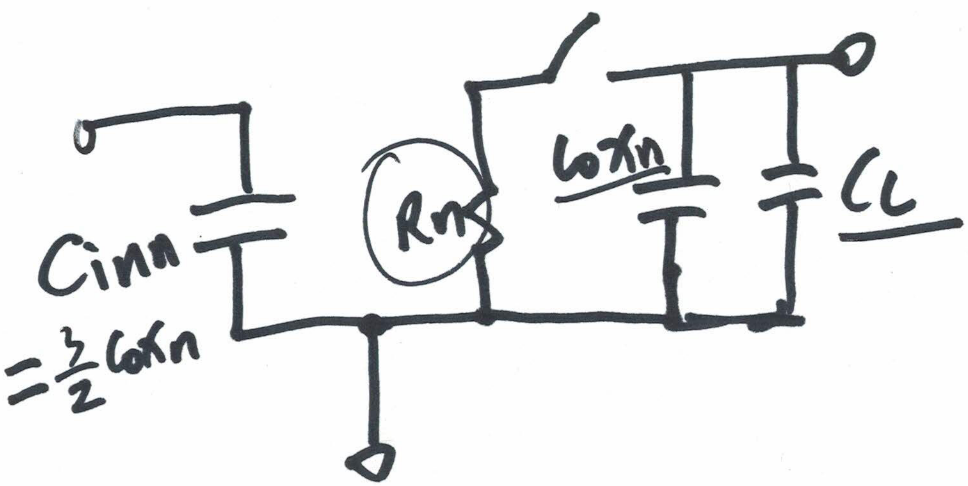


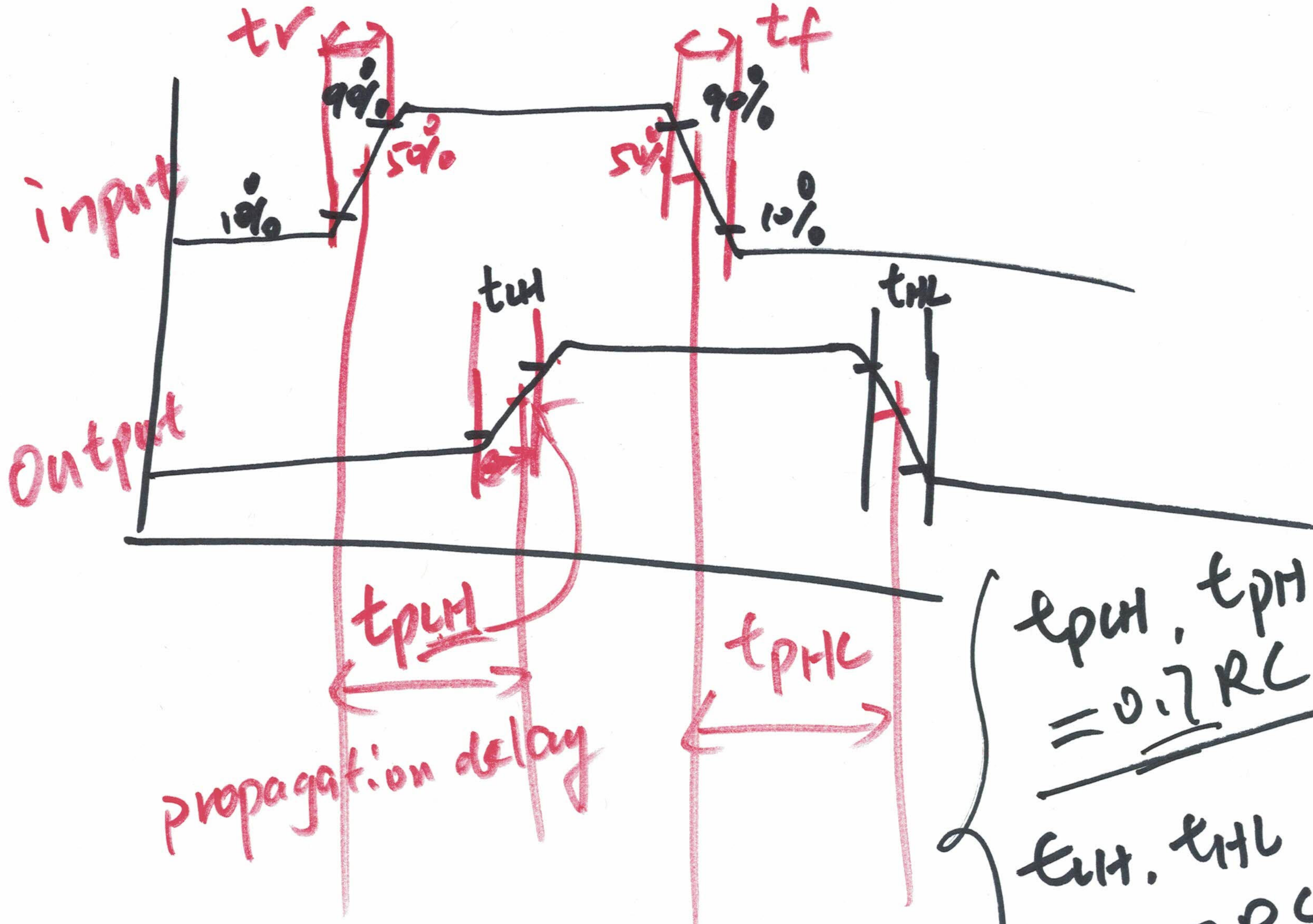




$$C_{ox} = C_{ox}' \cdot A = \frac{\varepsilon_{ox} \cdot \varepsilon_0}{t_{ox}} \cdot A$$

$$C_{eff_{in}} = C_{gs} + 2C_{gd} = \frac{3}{2} C_{ox}$$





t_{pLH}, t_{pHL} $= 0.7RC$

t_{LH}, t_{HL} $= 2.2RC$

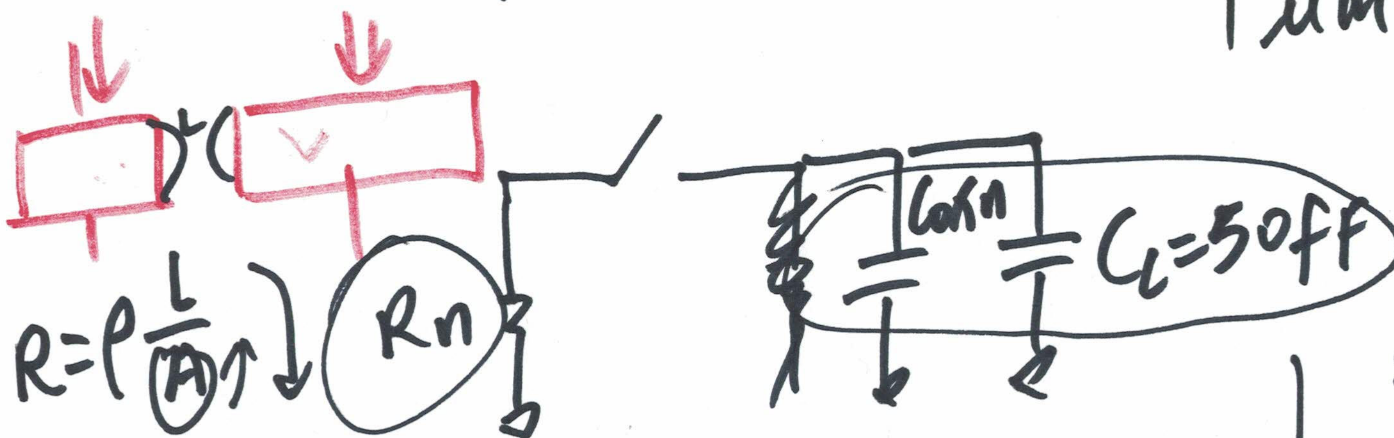
(P50 of the CMOS Book)

Example: t_{LH} t_{HL} t_{pLH}, t_{pHL}

estimate the rise, fall, and delay times (on output signal) of the following circuit. (P320)

	size	$R_{n,p}$	$C_{ox\,n,p}$
NMOS	10μ/1μ	1.5K	17.5fF
PMOS	30μ/1μ 60μ/1μ	1.5K	52.5fF

1 μm P317



$t_{LH} = t_{HL} = 2.2RC$

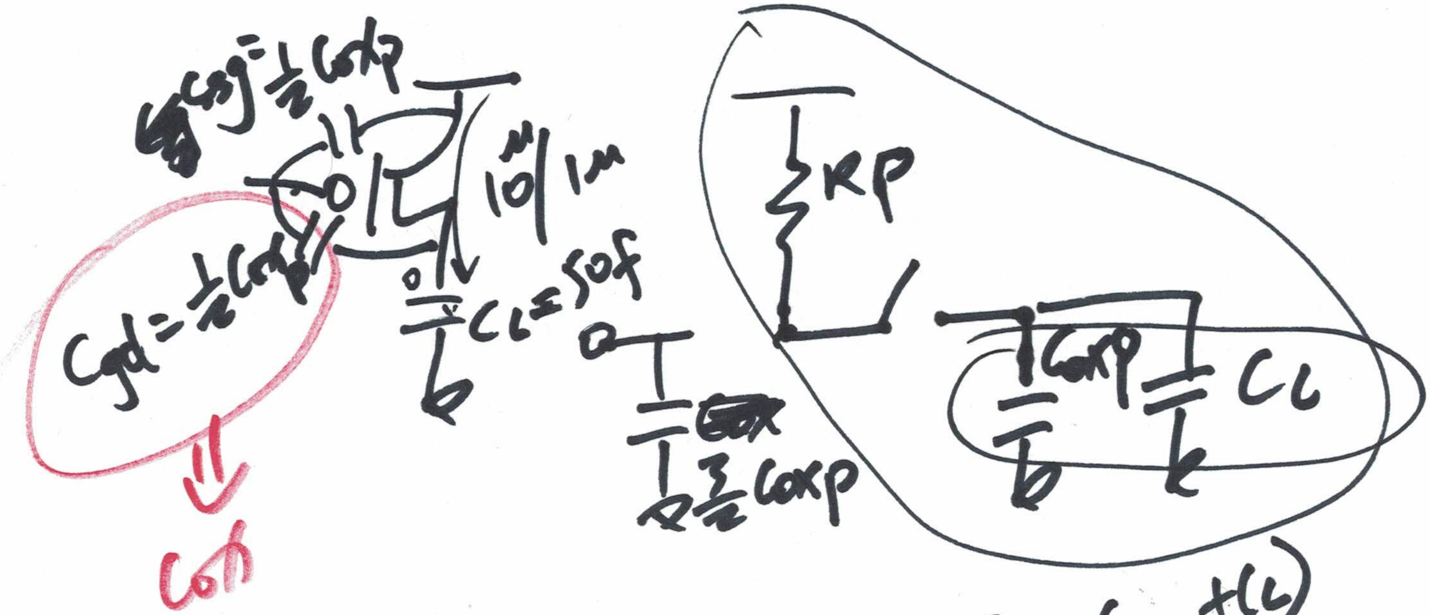
$= 2.2 \times R_n \cdot C_{tot}$ f

$= 2.2 \times 1.5K \cdot (17.5f + 50f)$

$= 220\,ps$

$t_{PHL} = 0.7RC = 0.7 \cdot R_n \cdot C_{tot}$

$= 0.7 \times 1.5K \cdot (17.5f + 50f) = 70\,ps.$



$$t_{LH} = 2.2\,RC = 2.2\,R_p(C_{oxp} + C_L) = 2.2 \cdot 4.5K \cdot (17.5f + 50f)$$

$$= 660ps$$

$R_p = 4.5K$

$C_{oxp} = 17.5fF$

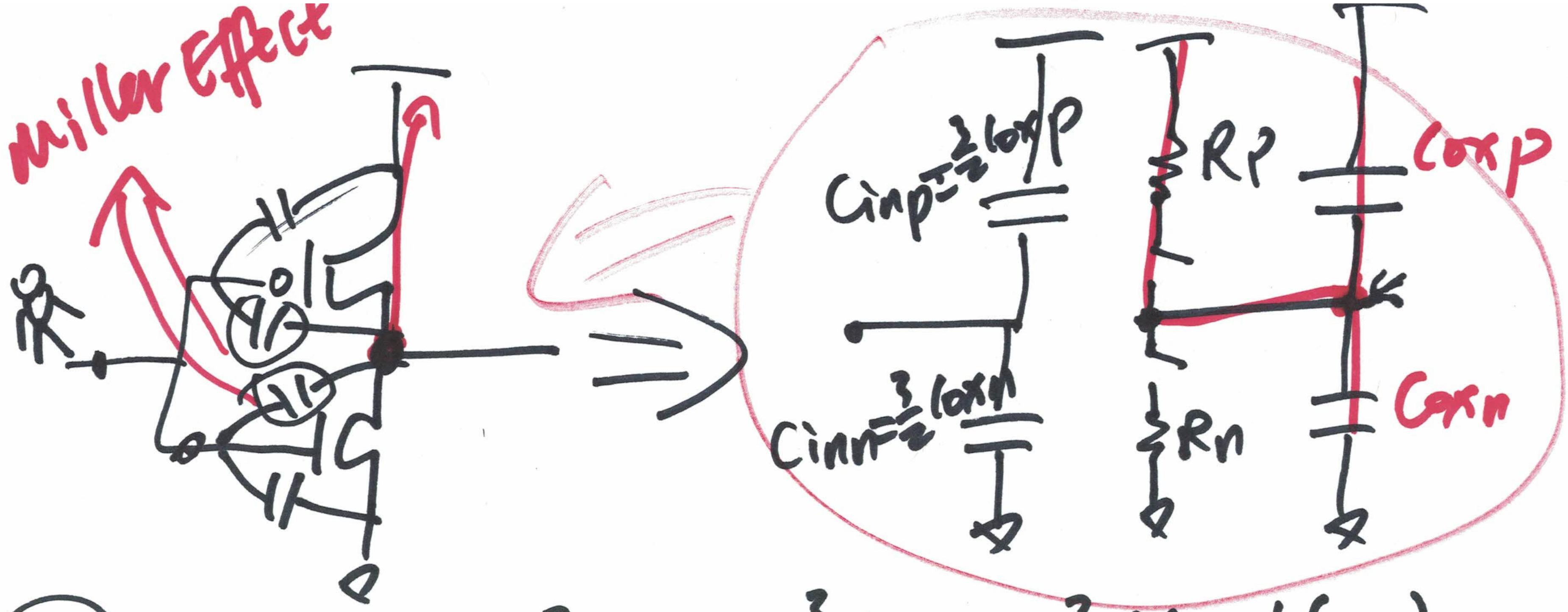
$$t_{pLH} = 0.7 \times 4.5K \times (17.5f + 50f)$$

$$= 210ps.$$

(A)

$C = \varepsilon d$

(b)



$$C_{in} = C_{inn} + C_{inp} = \frac{3}{2} C_{oxn} + \frac{3}{2} C_{oxp} = \frac{3}{2}(C_{oxn} + C_{oxp})$$

$$\begin{cases} t_{pLH} = 0.7 \cdot R_p \cdot (C_{oxn} + C_{oxp}) \\ t_{pHL} = 0.7 R_n (C_{oxn} + C_{oxp}) \end{cases}$$