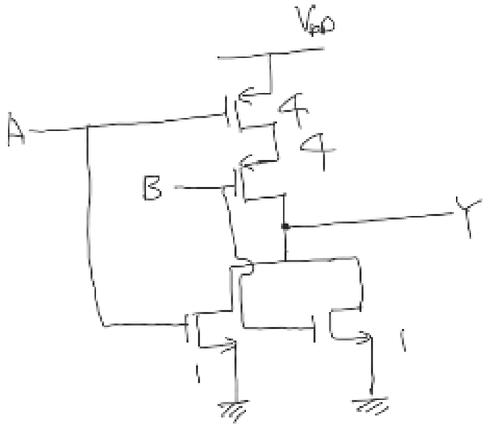
디집 HW6

4.1 2-input NOR



① Rising delay

i) PMOS 가 diffusion contact 을 공유 X 일 때.

$$\left(\frac{R}{2}\right)\cdot 8C + R(6C+5hC)$$
$$= (10+5h)RC$$

ii) 공유할 때.

$$\left(\frac{R}{2}\right)\cdot 4C + R(6C+5hC) = (8+5h)RC$$

② Falling delay

$$R(6C+5hC) = (6+5h)RC$$

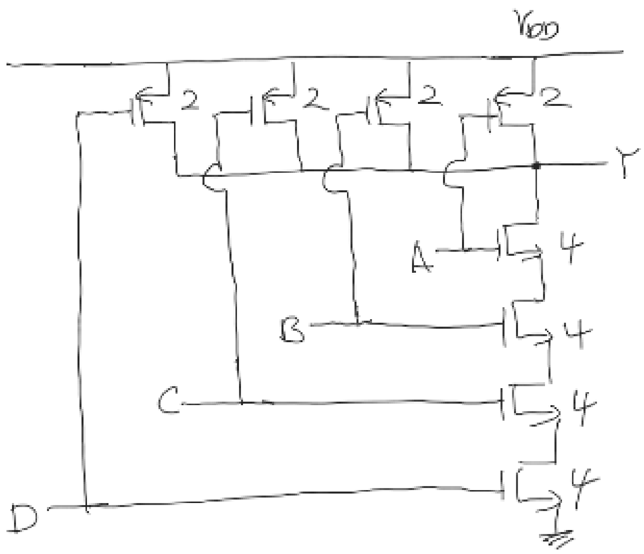
4.4 worst-case Elmore parasitic delay of n-input NOR

output node : $3nC$, each node : $2nC$

$$t_{pd} = R(3nC) + \sum_{i=1}^{n-1}\left(\frac{iR}{n}\right)(2nC) = (n^2+2n)RC$$

$$\frac{n(n-1)}{2} \qquad n^2 - n + 3n$$

4.9 4-input NAND

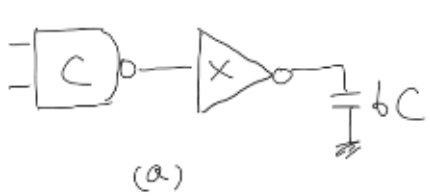


$C_{in} = (2+4)C$

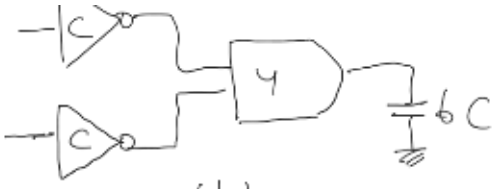
$C_{unit\text{-}inv} = (2+1)C$

$\therefore g = \frac{6}{3}$

4.10 2-input AND



(a)



(b)

$H=6,\ B=1,\ P=1+2=3,\ G=\frac{4}{3}$

$F=GBH=8,\ f=\sqrt{8}=2.8$

$P=2f+p=8.6\tau$

$x=6C-\frac{1}{f}=2.14C$

$H=6,\ B=1,\ P=3,\ G=\frac{5}{3}$

$F=GBH=10,\ f=\sqrt{10}=3.2$

$D=2f+p=9.3\tau$

$x=6C-\frac{1}{f}=3.16C$

따라서, (a)가 (b)보다 빠르다!

4.11 6-input AND gate.

Design	G	P	N	D(H=1)	D(H=5)	D(H=20)
(a)	$\frac{(6+2)C}{2C}\cdot 1=\frac{8}{3}$	7	2	10.3	14.3	24.6
(b)	$\frac{(3+2)C}{2C}\cdot\frac{5}{3}=\frac{25}{9}$	5	2	8.3	12.5	19.9
(c)	$\left(\frac{4}{3}\right)\left(\frac{2}{3}\right)=\frac{28}{9}$	5	2	8.5	12.9	20.8
(d)	$\left(\frac{5}{3}\right)\cdot 1\cdot\left(\frac{4}{3}\right)\cdot 1=\frac{20}{9}$	7	4	11.8	14.3	17.3

$D=N(GH)^{\frac{1}{N}}+P$

(b) design 이 H = 1, 5 일때 가장 빠르다.

(d) design 이 H=20 일때 가장 빠르다.

∴ (d)가 가장 낮은 logical effort를 가지고 있어 한 stage가 path effort를 감당하기 때문이다.

5.1 $\alpha=0.1,\ C=450\,pF/mm^2,\ V_{DD}=0.9,\ f=450MHz,\ A=100mm^2$

$P_{dynamic}=\alpha C V_{DD}^2 f \approx 1.15\,[W]$

5.4 $f_{clk}=1GHz$ $\alpha=?$

4bit의 변화 10cycle동안.

$x = \frac{1}{2} \cdot \frac{1}{5} = \frac{1}{5} = 0.2$

5.5 스위칭 횟수가 2-stage에서 가장 적기 때문에

가장 적은 energy 사용.

$d = x + \frac{64}{x} + 2 = 20$ $\qquad x^2 - 18x + 64 = 0$

$\therefore x = \frac{18 \pm \sqrt{18^2 - 4 \cdot 64}}{2} \approx 13.12,\ 4.88$

$x = 4.88$ (가장 작은 사이즈)

5.6 delay constraint $= 30\tau$

i) 2-stage

$d = x + \frac{500}{x} + 2 = 30$, $E = 1 + x$

$x^2 - 28x + 500 = 0$

$\therefore x \approx 30.85$ or -2.85

x가 음수가 돼서 delay constraint 만족 X.

ii) 3-stage

$d = x + \frac{y}{x} + \frac{500}{y} + 3 = 30$, $E = 1 + x + y$

$x^2y + y^2 + 500x - 27xy = 0$

if $x = 5$, $y^2 - 110y + 2500 = 0$

$\therefore y \approx 32.09$ and $E = 38.09$

iii) 4-stage

$d = x + \frac{y}{x} + \frac{z}{y} + \frac{500}{z} + 4 = 30$, $E = 1 + x + y + z$

$x^2yz + y^2z + xz^2 + 500xy - 26xyz = 0$

$$\begin{cases} x = 2.15 \\ y = 6.23 \\ z = 31.43 \end{cases} \Rightarrow E = 40.81$$

∴ 3-stage 시 Energy consumption 가장 작음

∴ 5-stage 가 energy consumption 가장 크다.

마지막 수정: 오후 5:59