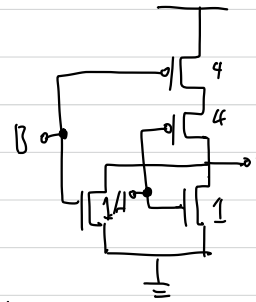
1, 4, 9, 10, 11
1, 4, 5, 6

HW#6

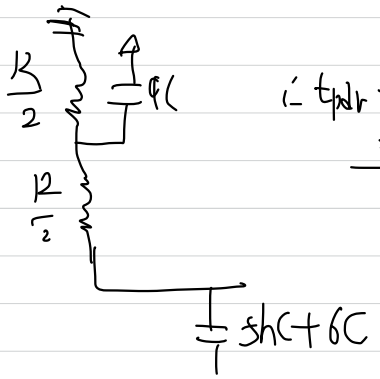
20175030 김산

4.1 2-in NOR.



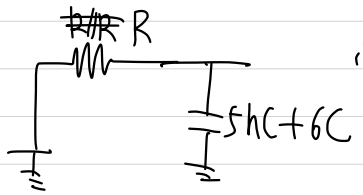
PUN : $2R \times 2 = 4R$.
PDN : worst $= R$.
$\frac{4R}{k_p} = \frac{R}{k_n}$, $\therefore k_p = 4, k_n = 1$.

i) t_{pdr}



$\therefore t_{pdr} = R \cdot 4C + R(5hC+6C)$
$= RC(10+5h)$

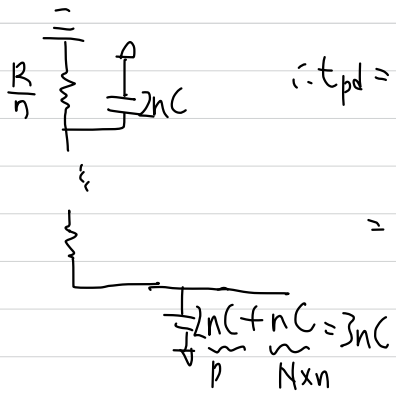
ii) t_{pdf} (worst 일때 R 1개만 on 일경우)



$\therefore t_{pdf} = RC(6+5h)$

4.4

$\frac{2R \cdot n}{k_p} = \frac{R}{k_n}$, $k_p = 2n$, $k_n = 1$.



$\frac{n(n-1)}{2} \times 2nC$

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

4.9

$\frac{2R}{k_p} = \frac{4R}{k_n}$, $k_p = 2, k_n = 4$

$g := \frac{C_{in,gate}}{C_{in,inverter}} = \frac{6RC}{3RC} = \frac{6}{3}$

$(p = GBH = \pi f_i)$

4.10 $D = D_p + P = \sum f_i + \sum p_i$

Each inputs will experience an inverter, so we have to compare the NAND(a), NOR(b) stages. Their parasitic cap is same to 2, but the logical effort of NOR(b) is bigger than NAND(a).
$\therefore$ (a) will be faster than (b)

(a) $G = \pi g_i = \frac{4}{3} \cdot 1 = \frac{4}{3}$, $B = 1$, $H = \frac{6C}{C} = 6$.
$\therefore p$(path effort) $= G \cdot H \cdot B = 8$
$D = \sum f_i + \sum p_i = [2\sqrt{8} + (1+2)]\tau \approx [4 \cdot 1.4 + 3]\tau \approx 8.6\tau$
$\therefore f_i = g_2 h_2$, $\frac{6C}{x} = f$, $x = \frac{6C}{2\sqrt{2}} \approx 2.14C$

(b) $G = \pi g_i = 1 \cdot \frac{5}{3} = \frac{5}{3}$, $B = 1$, $H = 6$.
$p = \frac{5}{3} \times 6 = 10$ $f_i = \sqrt{10} \approx 3.2$
$D = (3.2 \times 2 + 3)\tau = 9.4\tau$
$\therefore f_i = \frac{5}{3}\frac{3C}{Y}$, $Y = \frac{10C}{f_i} = \sqrt{10}C = 3.2C$

4.11

(a) $G = \frac{4}{3} \times 1 = \frac{4}{3}$, $P = 6+1 = 7$.
$D = 2\sqrt{\frac{4}{3}H} + 7$

(b) $G = \frac{5}{3} \times \frac{5}{3} = \frac{25}{9}$, $P = 5$
$D = 2 \times \frac{5}{3}\sqrt{H} + 5$

(c) $G = \frac{4}{3} \times \frac{4}{3}$, $P = 5$
$D = \frac{2}{3}\sqrt{2.5H} + 5$,

(d) $G = \frac{5}{3} \times 1 \times \frac{4}{3}$, $P = 3+1+2+1 = 7$
$D = 4\left(\frac{20}{9}H\right)^{\frac{1}{4}} + 7$.

	H=1	H=5	H=20
(a)	10.3	14.3	21.6
(b)	8.3	12.5	19.9
(c)	8.5	12.9	20.8
(d)	11.8	14.3	17.3

∴ For H=1, 5, (b) is fastest,
for H=20, (d) is fastest. (∵ more stages)

5.1

$P_{switch} = \alpha C V_{DD}^2 f$, $\alpha = 0.1$, $C = 450 \times 10$ p.
$= 0.1 \times 450 \times 10 \times 0.9^2 \times 450 \times 10^{-6}$
≈ 1.148 W

5.4

α = (portion of transition) $\times P = \frac{4}{10} \times \frac{1}{2} = 0.2$

5.5

2 stage will consume smallest power
(∵ The least switching is 2)

⊗ The required delay is determined.

⇒ Get $D_P = \Sigma f_i = \Pi g_i h_i$ (not $(GBH)^{\frac{1}{N}} = f_i$)

$\therefore D = 1 \cdot \frac{x}{1} + 1 \cdot \frac{64}{x} + 2 = 20$,
$x^2 - 18x + 64 = 0$, $x = 4.88$

5.6

i) 2 stages.
$\frac{x}{1} + \frac{500}{x} + 2 = 30$, $x^2 - 28x + 500 = 0$
$b'^2 - ac = 196 - 500 < 0$.
∴ To fit those conditions with 2 stages is impossible

ii) 3 stages.
$\frac{x}{1} + \frac{y}{x} + \frac{500}{y} = 30$, $\min(1+x+y)$ ($f(x,y)$)

$\Leftrightarrow x^2 + (\frac{500}{y} - 30)x + y = 0$, let $f(x,y) = 1+x+y$.

express y in function of x, and use matlab, 'fminbnd(-f(x))'

Then, for $x=5$, $y=32.09$, energy $= 38.09$