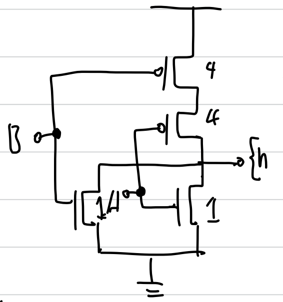
1, 4, 9, 10, 11
1, 4, 5, 6

HW#6

2017 5030 김산

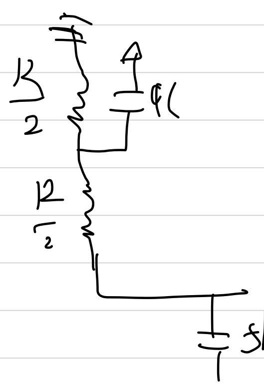
$\boxed{4.1}$ 2-in NOR.



PUN : $2R\times 2 = 4R$.
PDN : worst $= R$.

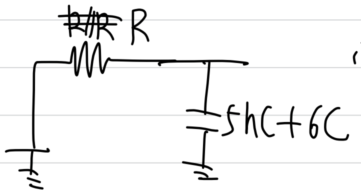
$\frac{4R}{k_p} = \frac{R}{k_n}$, $\therefore k_p = 4, k_n = 1$.

i) t_{pdr}



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

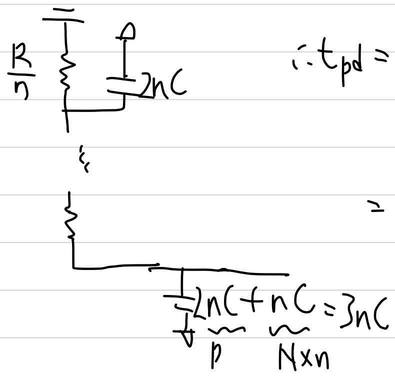
ii) t_{pdf} (worst 니까 R 1개만 on 가정)



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

$\boxed{4.4}$

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



$\frac{n(n-1)}{2}\cdot 2RC$

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

$= n(n-1)RC + 3nRC$

$= (n^2+2n)RC$

$\boxed{4.9}$

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

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

($F = GBH = \prod f_i$)

$\boxed{4.10}$ $D = D_F + P = \sum f_i + \sum p_i$

Each inputs will experience a inverter, so we have to compare the NAND(a), NOR(b) stages. Their parastic 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) $G = \prod g_i = \frac{4}{3}\cdot 1 = \frac{4}{3}$, $B = 1$, $H = \frac{6C}{C} = 6$.

$\therefore F$(path effort) $= G\cdot H\cdot B = 8$

$D = \sum f_i + \sum p_i = [2\cdot\sqrt{8} + (1+2)]\tau = [4.1.4+3]\tau = 8.6\tau$

$\therefore f_i = g_2 h_2$, $\frac{6C}{x} = f$, $x = \frac{6C}{2\sqrt{2}} \approx 2.14C$

(b) $G = \prod g_i = 1\cdot\frac{5}{3} = \frac{5}{3}$, $B = 1$, $H = 6$.

$F = \frac{5}{3}\times 6 = 10$ $\quad f_i = \sqrt{10} \approx 3.2$

$D = (3.2\times 2 + 3)\tau = 9.4\tau$

$\therefore f_i = \frac{5}{3}\frac{\frac{3}{5}C}{Y}$, $Y = \frac{10C}{f_i} = \sqrt{10}C = 3.2C$

4.11

(a) $G = \frac{8}{3} \times 1 = \frac{8}{3}$, $P = 6+1 = 7$.

$D = 2\sqrt{\frac{8}{3}H} + 7$

(b) $G = \frac{5}{3} \times \frac{5}{3} = \frac{25}{9}$, $P = 5$

$D = 2 \times \frac{5}{3}\sqrt{H} + 5$

(c) $G = \frac{4}{3} \times \frac{7}{3}$, $P = 5$

$D = \frac{2}{3}\sqrt{28H} + 5$,

(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

$P_{switch} = \alpha C V_{DD}^2 f$, $\alpha = 0.1$, $C = 450 \times 70\,p$.

$= 0.1 \times 450 \times 70 \times 0.9^2 \times 450 \times 10^{-6}$

$\approx 1.148\ W$ //

5.4

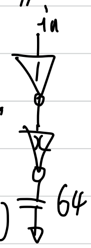
$\alpha :=$ (portion of transition) $\times P = \frac{4}{10} \times \frac{1}{2} = 0.2$ //

5.5

2 stage will consume smallest power //

(∵ The least switching is 2)

∵ The required delay is determined.



⇒ Get $D_F = \sum f_i = \prod g_i h_i$ (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.

$\frac{x}{1} + \frac{y}{x} + \frac{500}{y} = 30$, $\min(\underbrace{1+x+y}_{f(x,y)})$ //

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

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

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

iii) 4 stages.

$\frac{x}{1} + \frac{y}{x} + \frac{z}{y} + \frac{500}{z} = 30$, $\min(1+x+y+z)$

Solve in same way,

for, $x = 2.15$, $y = 6.23$, $z = 31.43$, energy $= 39.81$

From i), ii), iii), 3 stage has least power //