DIC HW#6

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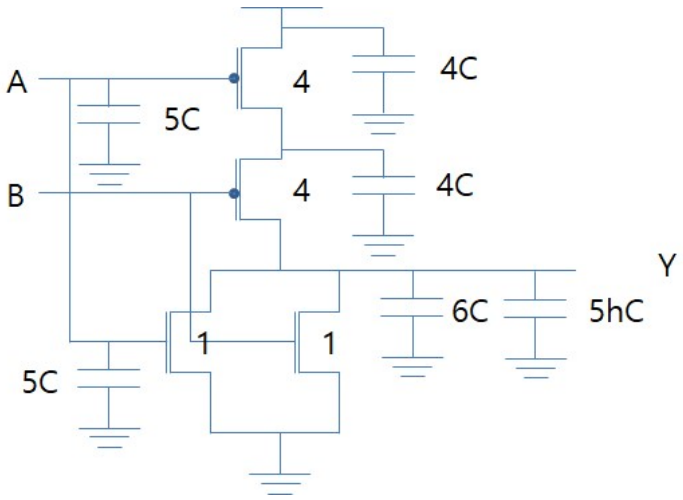
4.1



$$t_{rising} = \frac{R}{2} \times (4C + 4C) + R \times (6C + 5hC) = (10 + 5h)RC$$

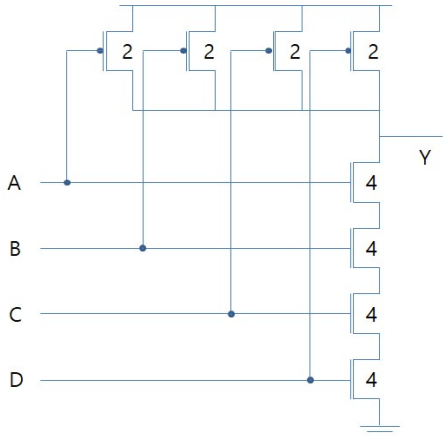
$$t_{falling} = R \times (6C + 5hC) = (6 + 5h)RC$$

4.4

Each of Pull-up network elements(PMOS) has R/n, and Pull-down network elements(NMOS) has R. Also Input node has 2nC, and output nod has 3nC. Then the propagation delay is

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

4.9



$$g = (2 + 4)/(1 + 2) = 6/3$$

4.10

$H = 6, P = 3, B = 1$

(a)

$F = GBH = 8$

$f = \sqrt{F} = 2.83$

$D = 2f + P = 8.66$

(b)

$F = GBH = 10$

$f = \sqrt{F} = 3.16$

$D = 2f + P = 9.32$

Therefore (a) is faster then (b).

4.11

For (a),

$G = 8/3, P = 7, N = 2$

$D_{H=1} = 2(8/3 \times 1)^{\frac{1}{2}} + 7 = 10.3$

$D_{H=5} = 2(8/3 \times 5)^{\frac{1}{2}} + 7 = 14.3$

$D_{H=20} = 2(8/3 \times 20)^{\frac{1}{2}} + 7 = 21.6$

For (b),

$G = 5/3 \times 5/3, P = 5, N = 2$

$D_{H=1} = 2(5/3 \times 5/3 \times 1)^{\frac{1}{2}} + 5 = 8.3$

$D_{H=5} = 2(5/3 \times 5/3 \times 5)^{\frac{1}{2}} + 5 = 12.5$

$D_{H=20} = 2(5/3 \times 5/3 \times 20)^{\frac{1}{2}} + 5 = 19.9$

For (c),

$G = 4/3 \times 7/3, P = 5, N = 2$

$D_{H=1} = 2(4/3 \times 7/3 \times 1)^{\frac{1}{2}} + 5 = 8.5$

$D_{H=5} = 2(4/3 \times 7/3 \times 5)^{\frac{1}{2}} + 5 = 12.9$

$D_{H=20} = 2(4/3 \times 7/3 \times 20)^{\frac{1}{2}} + 5 = 20.8$

For (d),

$G = 5/3 \times 1 \times 4/3 \times 1, P = 7, N = 4$

$$D_{H=1} = 4(5/3\times1\times4/3\times1\times1)^{\frac{1}{4}} + 5 = 11.8$$
$$D_{H=5} = 4(5/3\times1\times4/3\times1\times5)^{\frac{1}{4}} + 5 = 14.3$$
$$D_{H=20} = 4(5/3\times1\times4/3\times1\times20)^{\frac{1}{4}} + 5 = 17.3$$

H=1, H=5, (b) is fastest.
H=20, (d) is fastest.

5.1
$$P = 0.1\times(450\times10^{-12}\times70)\times(0.9)^2\times450\times10^6 = 1.08\,W$$

5.4
Since there are 2 rising edges for 10ns, (2/10) = 0.2

5.5
Use only two inverter for buffer since we make the least power consumption to spend each inverter.
$d = x + 64/x + 2 = 20$
$\therefore x = 4.88$

5.6
(2stage)
$d = x + 500/x + 2 = 20, E = 1 + x$
There is no answer for x.

(3stage)
$d = x + y/x + 500/y + 3, E = 1 + x + y$
$x = 5, y = 32.09, E = 38.09$

(4stage)
$d = x + y/x + z/y + 500/z + 4, E = 1 + x + y + z$
$x = 2.15, y = 6.23, z = 31.43, E = 39.81$

Therefore, 3stage design is best for power efficiency.