In the name of god

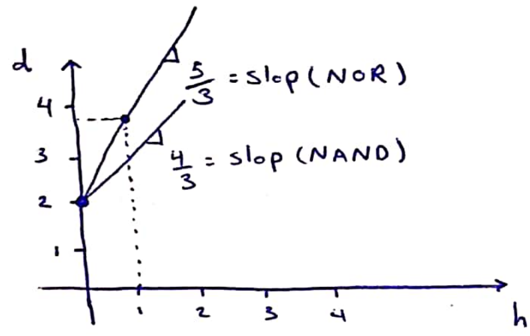
Reza Adinepour

402131055

HW 04

4.5: for 2-input NOR gate I know $\begin{cases} g = \frac{5}{3} \\ P = 2 \\ d = gh + P = \frac{5}{3}h + 2 \end{cases}$

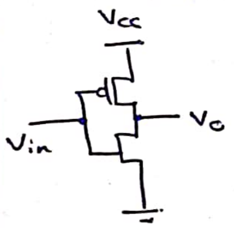
h	0	1	2
d	2	3.6	5.3



for 2-input NAND gate $\begin{cases} g = \frac{4}{3} \\ P = 2 \\ d = gh + P = \frac{4}{3}h + 2 \end{cases}$

slop of NOR $>$ Slop of NAND
$(\frac{5}{3})$ $(\frac{4}{3})$

4.6: Unit inverter has 3 units of Capacitance (2 from PMOS and 1 from nMOS). For 4X inverter nMOS is now 4 unit and PMOS is $2 \times 4 = 8$ unit. and for a total of $8 + 4 = 12$ unit



- logical effort is 1 and $P = P_{inv}$

- changing the size does not change the logical effort or Parasitic delay from that of the 1X

4.7: The delay can be improved because each stage should have equal effort and that effort should be about 4. This design has imbalanced delays and excessive efforts.

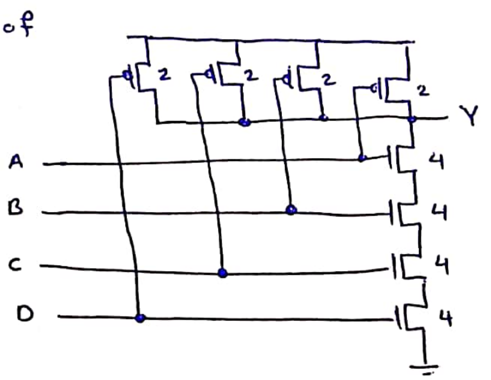
The path effort is $F = 12 \times 6 \times 9 = 648$. The best number of stage is 4 or 5. on way to speed the Circuit up is to add a buffer at the end. The gates should be resized to bear offerts of $f = 648^{\frac{1}{5}} = 3.65$. Now the effort delay is only $D_F = 5f = 18.25$ as compared to $12 + 6 + 9 = 27$. The Parasitic delay increases by $2P_{inv}$, but this is still a substantail speedup.

4.8: Drive is defined as C_{in}/g,

a) for unit invertor g is 1, C_{in} is 3 units and $\frac{C_{in}}{g} = 3$
This Corresponds to 1 unit of drive for 4X unit cap g unchanged
C_{in} is 4, making $X = 4$

b) NAND2 has a g of $\frac{4}{3}$. if the nand also has 3 units of Input cap, then $\frac{C_{in}}{g} = \frac{9}{4}$. But if a unit inverter with a $\frac{C_{in}}{g} = 3$ has unit drive, then this inverter is $\frac{3}{4}$ units of drive.

4.9: $g = \frac{6}{3}$ is is ratio of the input capacitance 4+2 to that of a unib inverter 2+1



4.10: should be faster than (b) because the NAND has the Same Parasitic delay but lower logical effort than the NOR in each design,

$H = 6$, $B = 1$, $P = 1+2 = 3$

for (a) $G = \frac{4}{3}$, $F = GBH = 8$, $f = \sqrt[2]{8} = 2.8$, $D = 2f + P = 8.6\tau$

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

for (B): $G = \frac{5}{3}$, $F = GBH = 10$, $f = \sqrt{10} \Rightarrow 3.2$, $D = 2f + P = 9.3\tau$

$x = 6C \times \frac{\frac{5}{3}}{f} = 3.16C$