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NPTEL ONLINE CERTIFICATION COURSE

VLSI Physical Design with Timing Analysis

Lecture – 18: STA for Combinational Circuits – II

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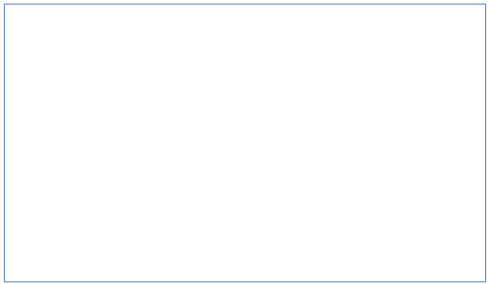
Contents

- Critical Path finding

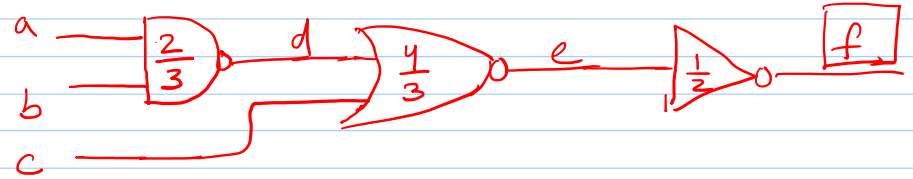


Inverting type of gates

1. Output rise A.T. = max(input fall A.T.) + Rise delay
2. Output fall A.T. = max(input rise A.T.) + fall delay
3. input rise A.T. =
   input rise R.T. = min (output fall R.T.) − fall delay
4. input fall A.T.
   input fall R.T. = min (output rise A.T.) − rise delay

Ex:1

Given $\left(\frac{\text{Rise delay}}{\text{fall delay}}\right)$ for each gate



rise / fall A.T. node "a" = 0/0

" " " "b" = 0/0

" " " "c" = 0/0

R.T. at node "f" = 5/11

(i) Find the R.T. at each node

(ii) Find the slack at each node

(iii) Critical path in the circuit

Node a A.T. = 0/0 ← Rise A.T, ← fall A.T.

R.T. = 2/−1

Slack = 2/−1

Node b A.T. = 0/0

R.T. = $\frac{5-3}{1-2} = \frac{2}{-1}$

Slack = 2/−1

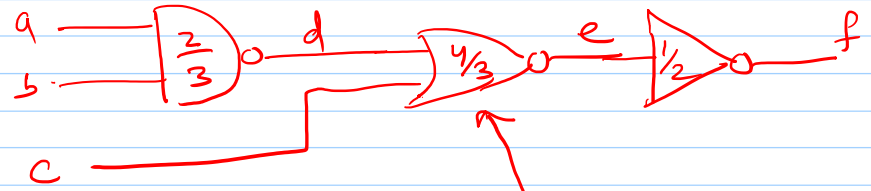
o/p R.T. fall = 5 ; fall delay (NAND) = 3

o/p R.T. rise = 1 ; rise delay (NAND) = 2

Node C : A.T. $= \frac{0}{0}$

R.T. $= \frac{1}{5}$

Slack $= \frac{1-0}{5-0} = \frac{1}{5}$



Node d : A.T. $= \frac{2}{3}$ ← i/p fall A.T. = 0 ; Rise delay = 2
3 ← i/p rise A.T. = 0 ; fall delay = 3

R.T. $= \frac{4-3}{9-4} = \frac{1}{5}$ [o/p. fall R.T. = 4 ; fall delay (NOR) = 3
o/p rise R.T. = 9 rise delay (NOR) = 4

Slack. $= \frac{-1}{2}$

Node e A.T. $= \frac{3+4}{2+3} = \frac{7}{5}$ ← [i/p fall A.T. = 3 ; Rise delay = 4
i/p rise A.T. = 2 Fall delay = 3

R.T. $= \frac{11-2}{5-1} = \frac{9}{4}$ [o/p. fall R.T. = 11 ; fall delay = 2
o/p rise R.T. = 5 ; rise delay = 1

Slack = R.T. − A.T.
$= \frac{9-7}{4-5} = \frac{2}{-1}$

Slack $= \frac{2}{-1}$

Node f

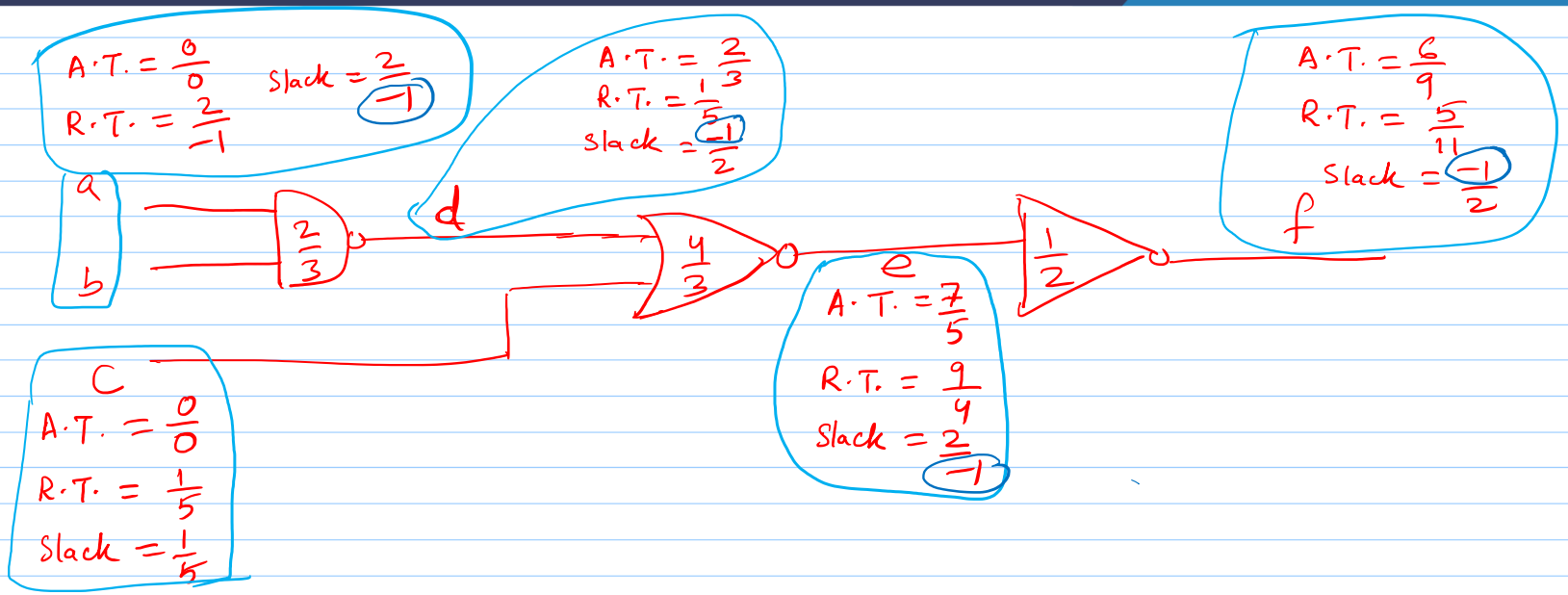
$$A.T. = \frac{5+1}{7+2} = \frac{6}{9}$$

i/p A.T. fall = 5 ; Rise delay = 1

i/p A.T. rise = 7 fall delay = 2

Given $R.T. = \frac{5}{11}$

$$\text{Slack} = R.T. - A.T. = \frac{R.T.(\text{Rise}) - A.T.(\text{Rise})}{R.T.(\text{fall}) - A.T.(\text{fall})} = \frac{5-6}{11-9} = \frac{-1}{2}$$



"f" rising → "e" falling → "d" rising → "a/b" falling

Thank You