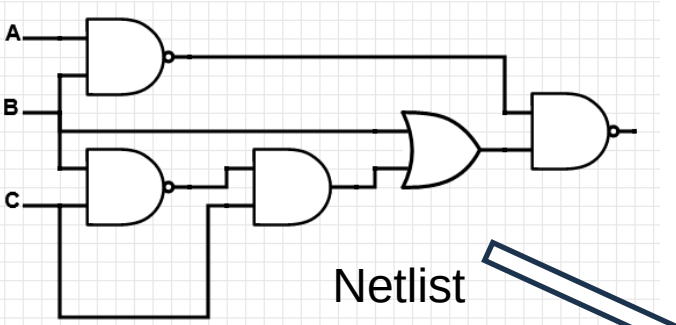
Testability of VLSI

Lecture 6A: Testability Measures

By Dr. Sanjay Vidhyadharan

Fault Simulation



Netlist

Collapsed Fault list
A0, A1, B0…

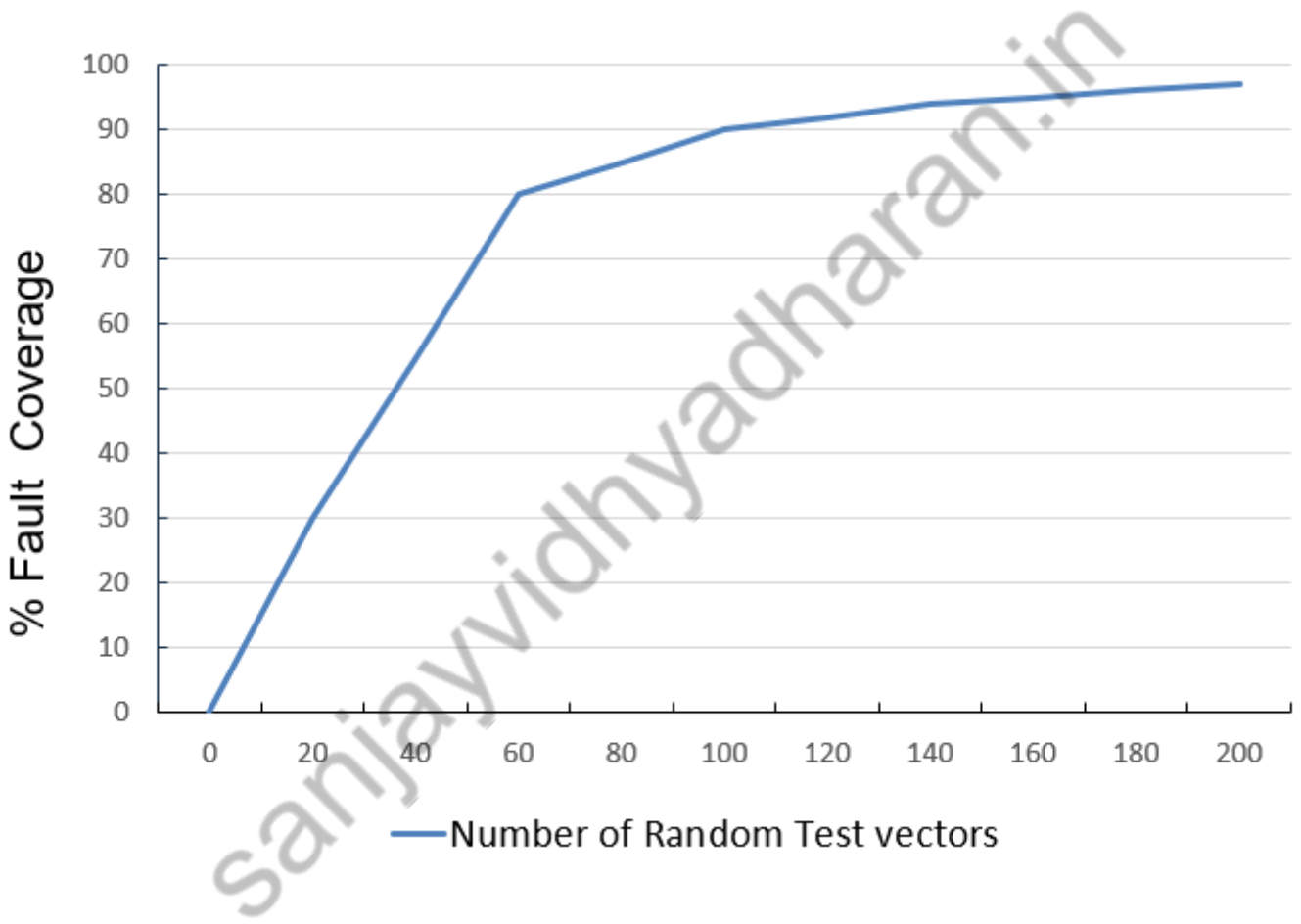
Fault Simulator

Fault Statistics

Text Vectors

Automatic Test pattern generation

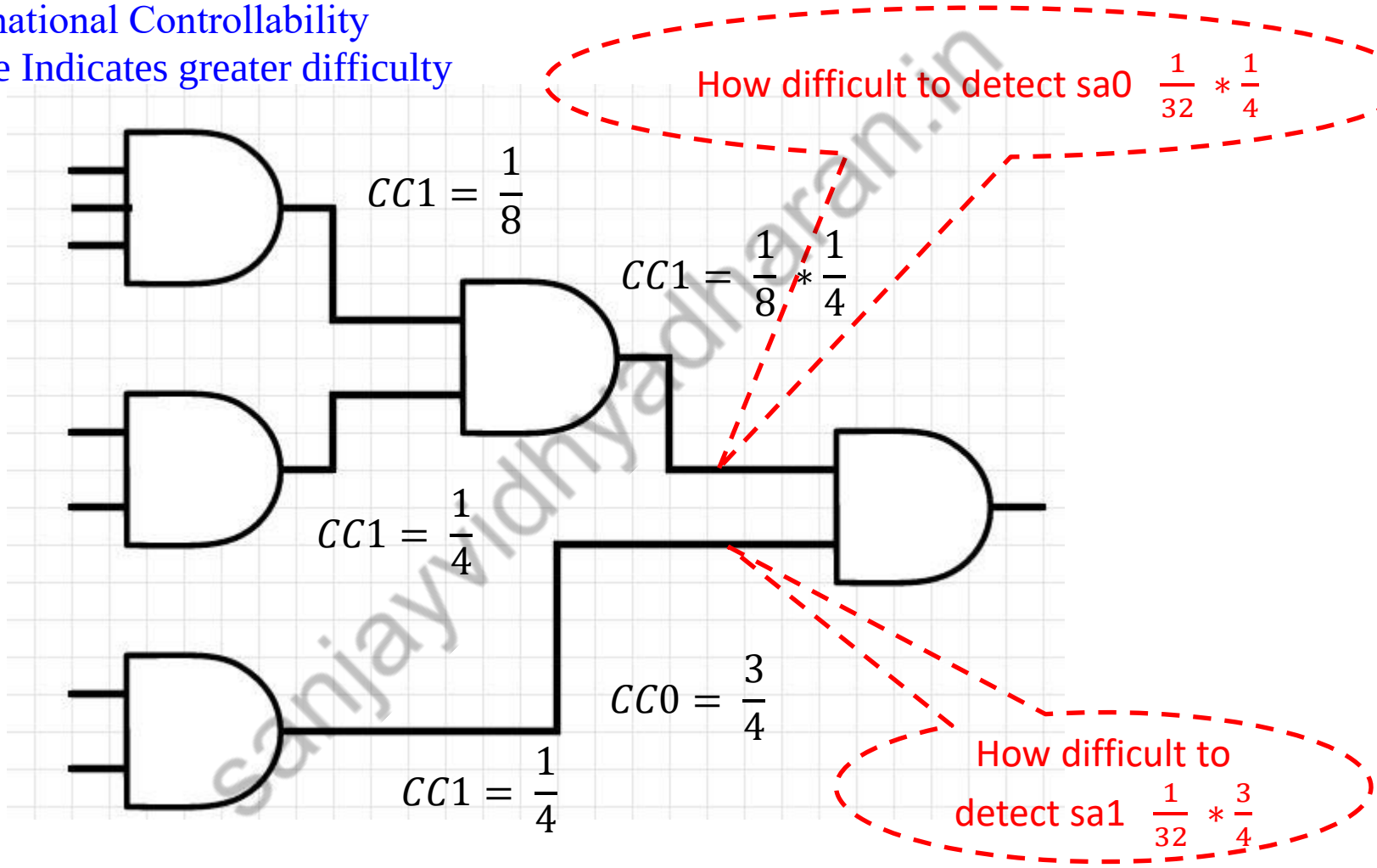
TESTABILITY MEASURES



We need an algorithm to find which are difficult fouls to detect using random sequence of Test vectors to apply Sensitization , Propagation and Justification

Setting Difficulty levels

CC-Combinational Controllability
Lower Value Indicates greater difficulty



Inefficient Algorithm

TESTABILITY MEASURES

SCOAP Controllability and Observability

Sandia Controllability/Observability Analysis Program.

SCOAP consists of six numerical measures for each signal (l) in the circuit:

1. Combinational 0-controllability, $CC0(l)$
2. Combinational 1-controllability, $CC1(l)$
3. Combinational observability, $CO(l)$
4. Sequential 0-controllability, $SC0(l)$
5. Sequential 1-controllability, $SC1(l)$
6. Sequential observability, $SO(l)$

Combinational SCOAP Measures

1. Set the difficulty of controlling each *primary input* (PI) to 0 (called *CC*0) to the value 1 and the difficulty of controlling each PI to 1 (called *CC*1) to the value 1.

2. We progress through the circuit in a forward pass, in *level order.* For each logic gate that we traverse, we add 1 to the controllability. This accounts for the logic depth.

(i) If a logic gate output is produced by setting only one input to a controlling value, then:

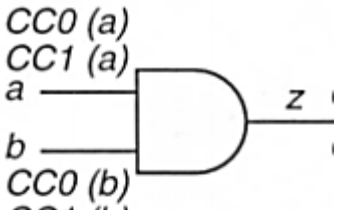
$$\text{output controllability} = min\ (\text{input controllabilities}) + 1$$

(ii) If a logic gate output can only be produced by setting all inputs to a non-controlling value, then:

$$\text{output controllability} = \sum(\text{input controllabilities}) + 1$$

Combinational SCOAP Measures

SCOAP controllability calculation



$CC0(z) = \min(CC0(a), CC0(b)) + 1$

$CC1(z) = CC1(a) + CC1(b) + 1$

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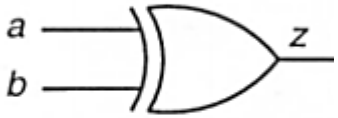

$CC0(z) = \min(CC0(a) + CC0(b), CC1(a) + CC1(b)) + 1$

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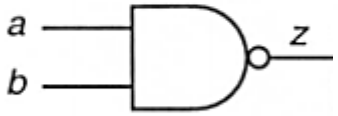

$CC0(z) = CC1(a) + CC1(b) + 1$

$CC1(z) = \min(CC0(a), CC0(b)) + 1$

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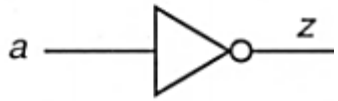


$CC0(z) = CC1(a) + 1$

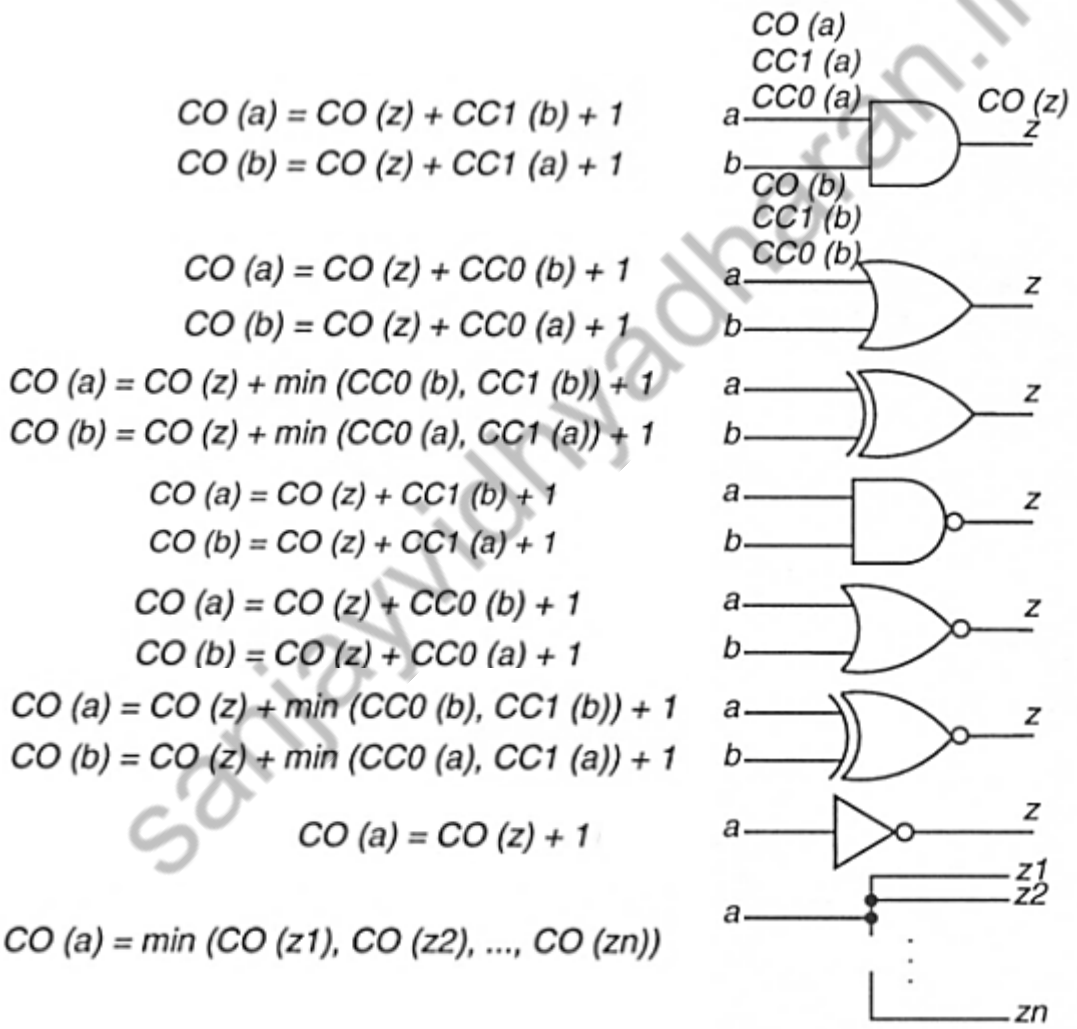
$CC1(z) = CC0(a) + 1$

Combinational SCOAP Measures

3. After all controllabilities are established, we compute observabilities in a reverse pass starting from primary outputs (POs) and moving backwards to the PIs. We first set the output observability difficulty (called CO) to 0, making no distinction between logic 0 and 1 in observabilities.
4. For a logic gate with an input signal that needs to be observed, the difficulty of observing that input equals the observability of the output plus the difficulty of setting all other inputs to non-controlling values, plus 1 to account for the logic depth.

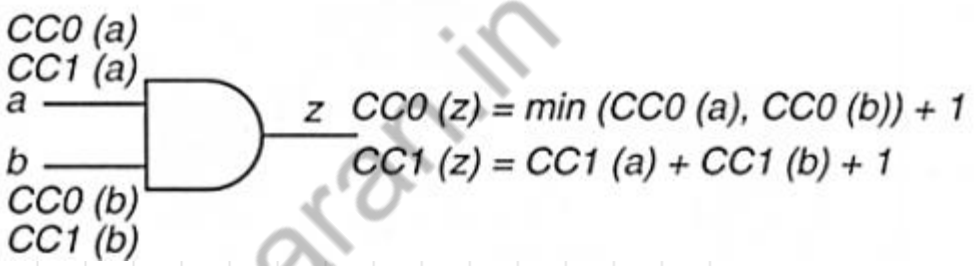
Combinational SCOAP Measures

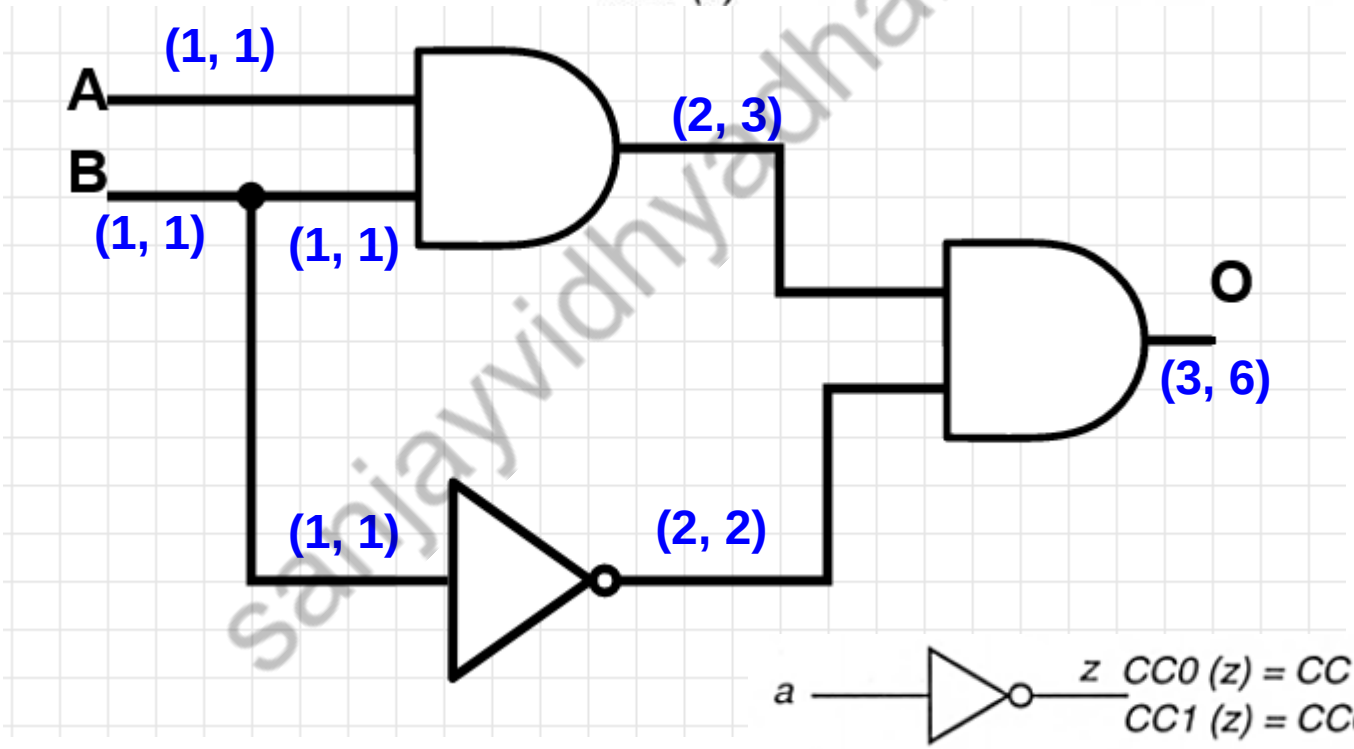
SCOAP observability calculation



Combinational SCOAP Measures

(CC0, CC1)

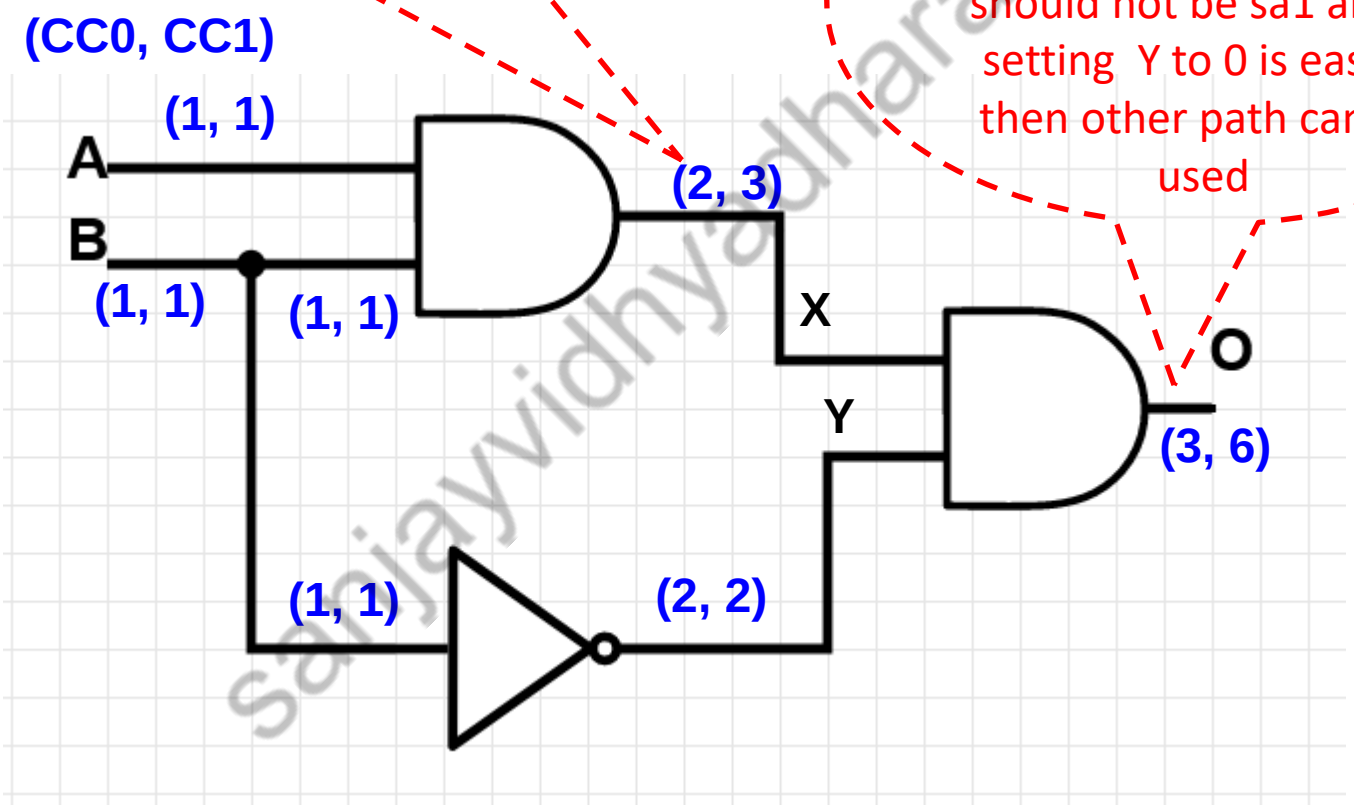




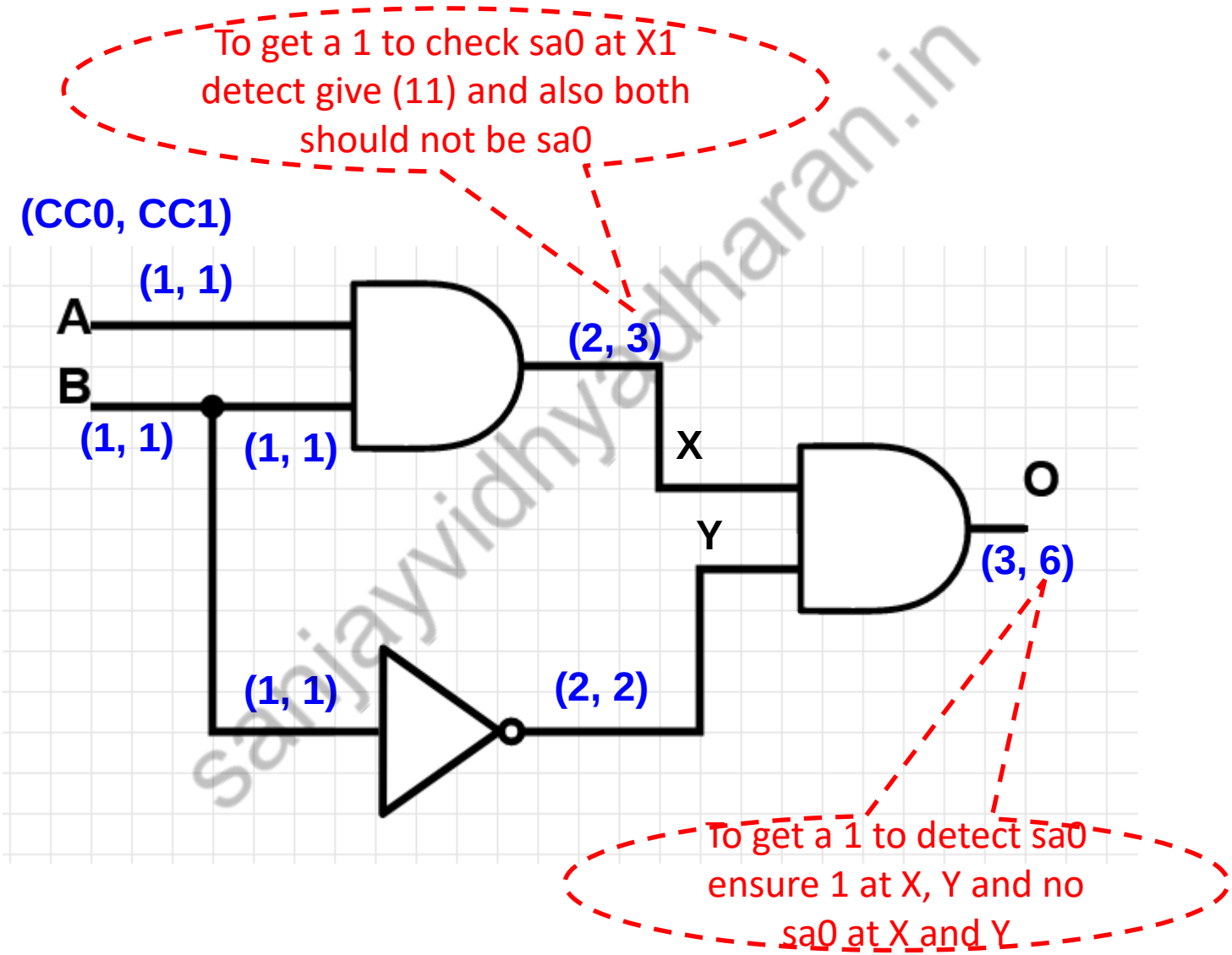
Combinational SCOAP Measures

To get a 0 to check sa1 at X give (0,0 or 0,1 or 1,0) and both inputs together should not be sa1

If 0 required at O Additional condition is O should not be sa1 and if setting Y to 0 is easier, then other path can be used

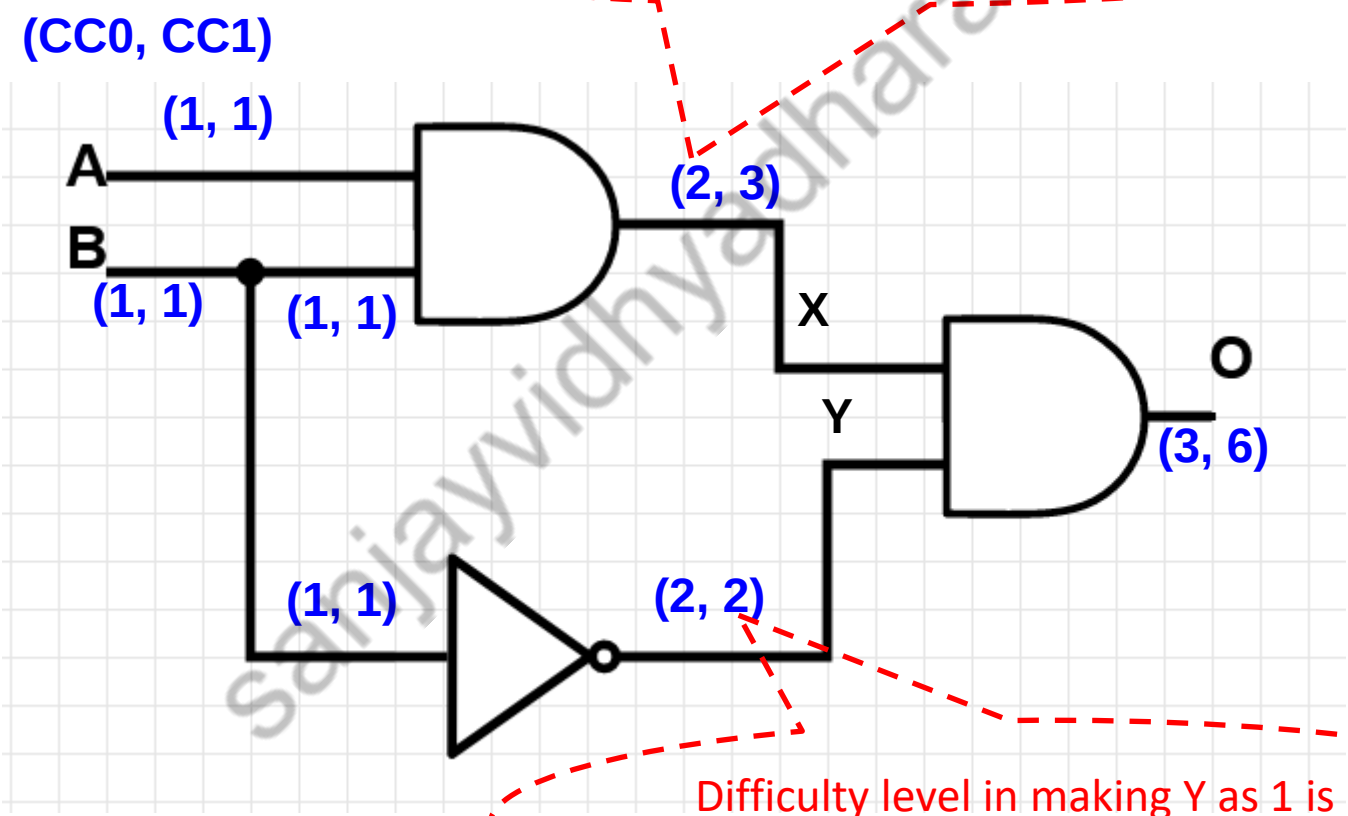


Combinational SCOAP Measures



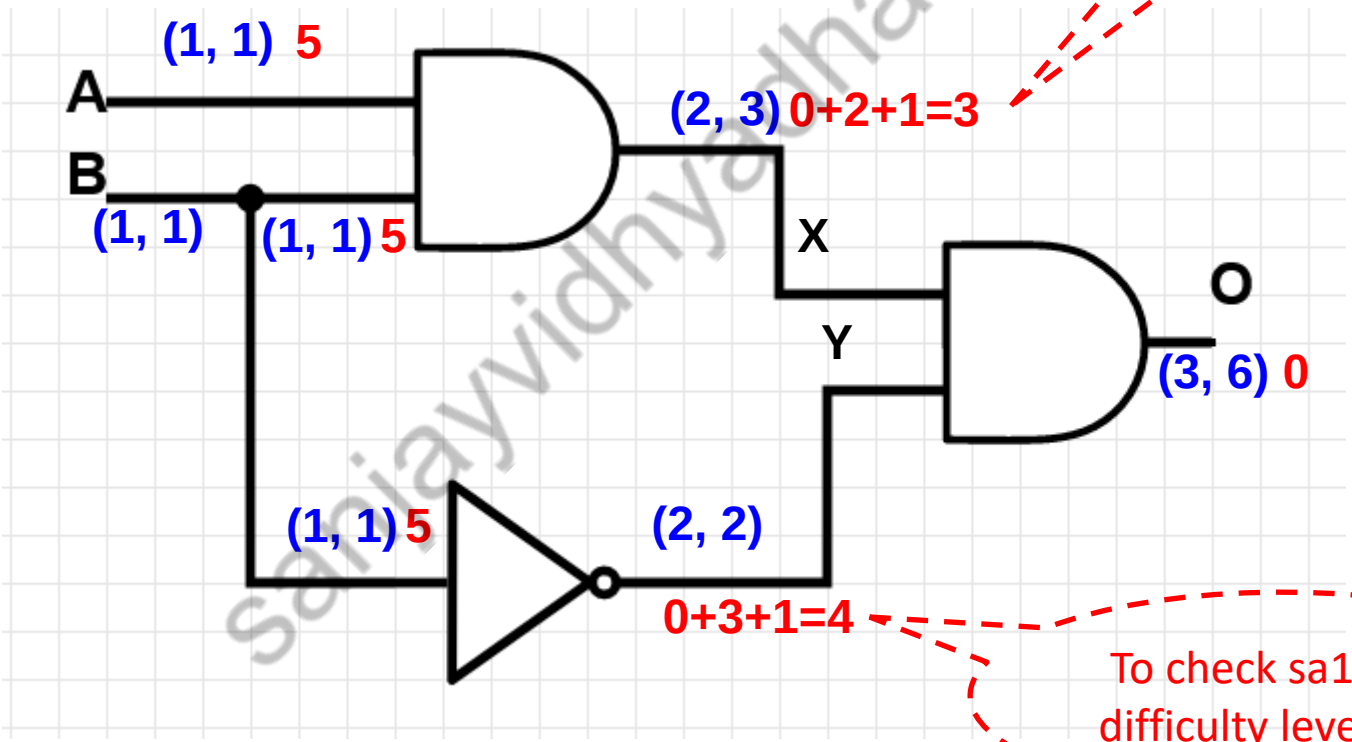
Combinational SCOAP Measures

To get a 0 to check sa1 difficulty level 2. To observe at O need to make Y as 1.



Difficulty level in making Y as 1 is not same as difficulty level making X as 1

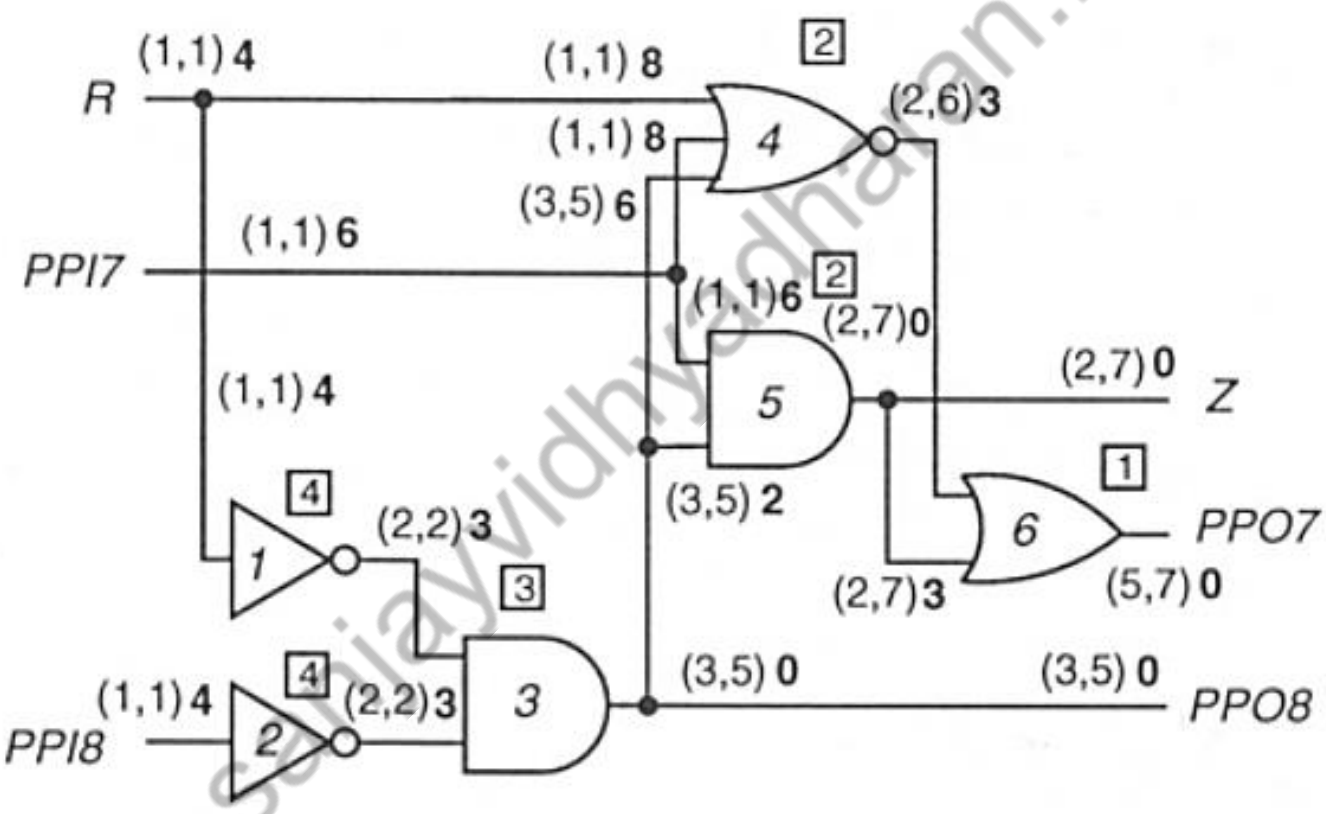
Combinational SCOAP Measures



To check sa1 here difficulty level 2+3

To check sa1 here difficulty level 2+4

Combinational SCOAP Measures



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2. Video lectures by Professor James Chien-Mo Li
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National Taiwan University
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3. NPTEL Lectures
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Thankyou