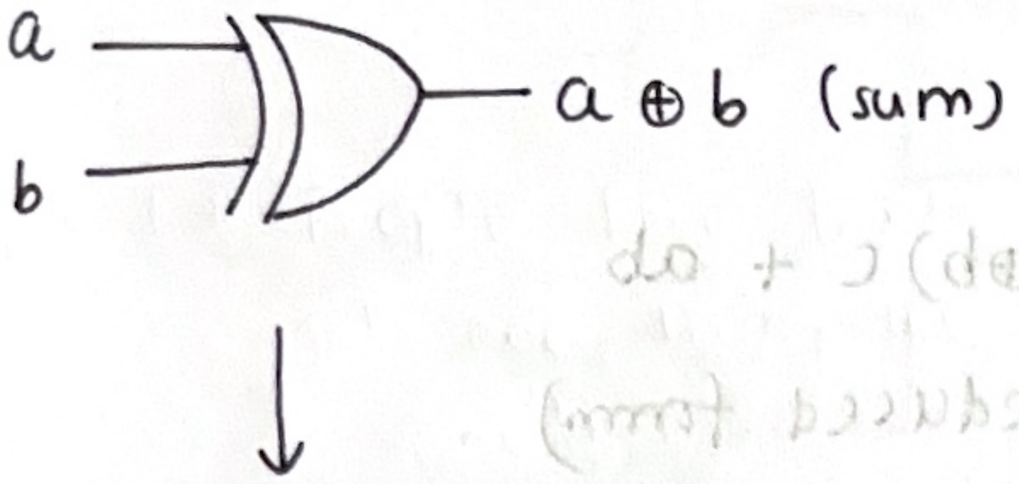
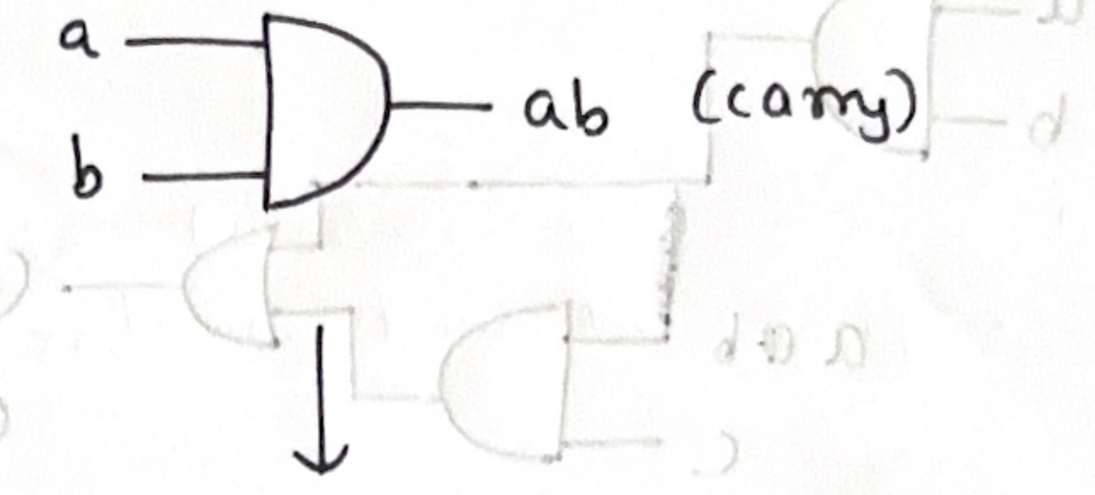
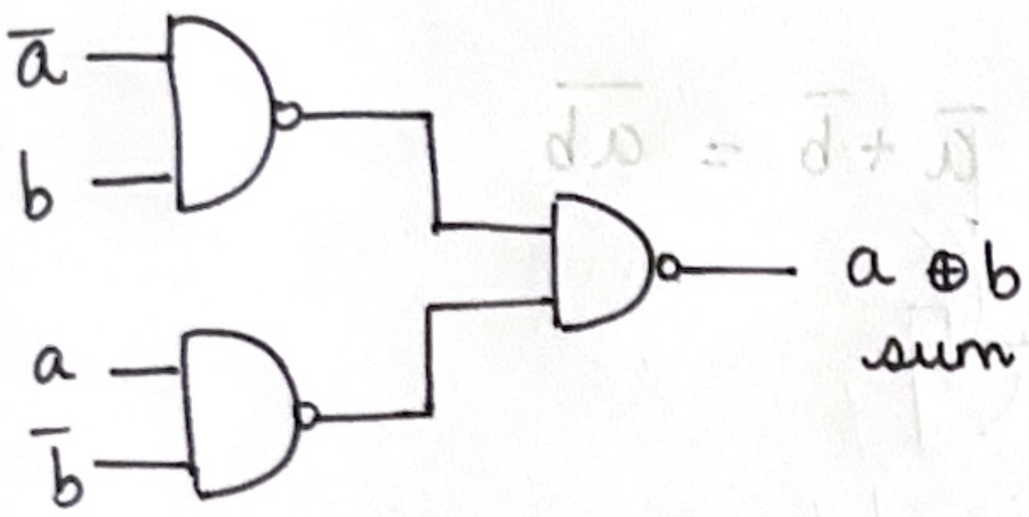
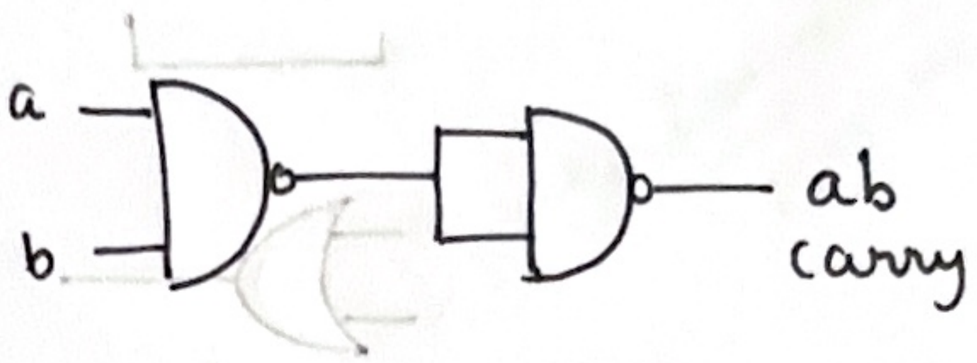
August 1 lab, 2025

★ Half adder:





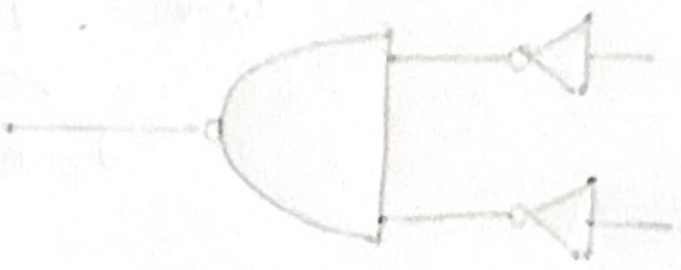




and = $ab = \overline{(\overline{ab})}$

xor: $\bar{a}b + \bar{b}a = \overline{\overline{\bar{a}b + \bar{b}a}}$

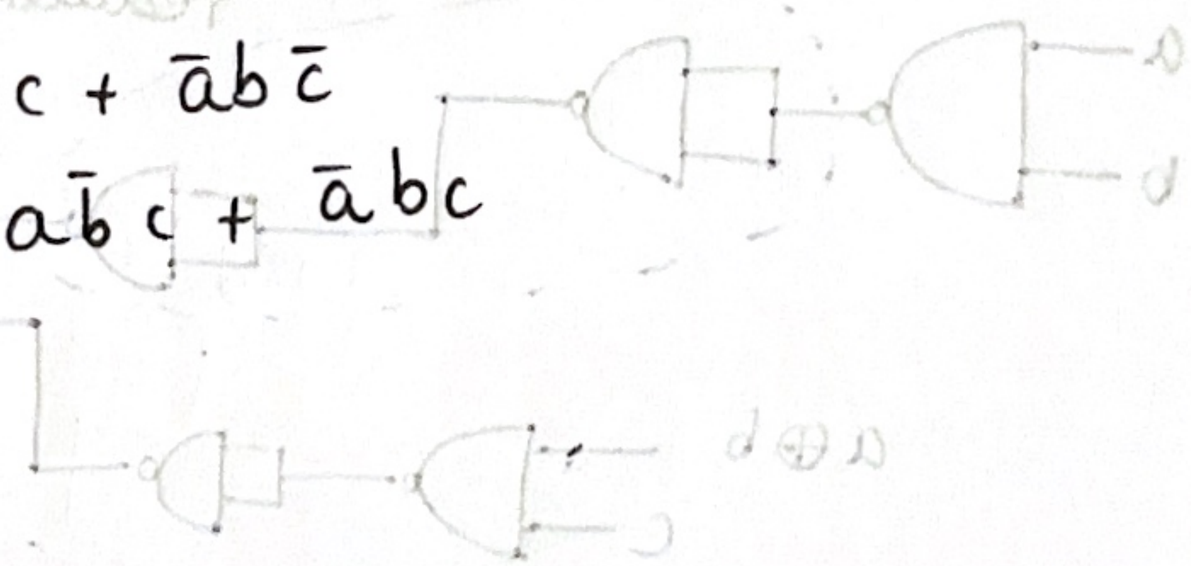
$= \overline{\overline{(\bar{a}b)}\,\overline{(\bar{b}a)}}$



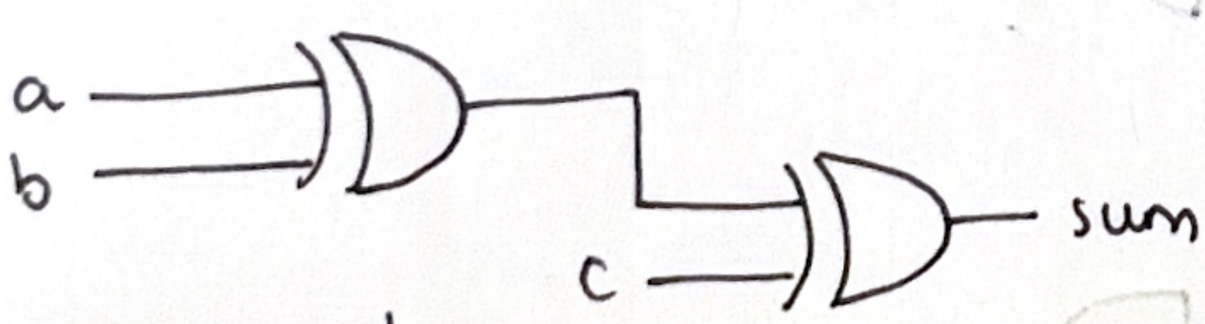
★ Full adder:

sum = $abc + a\bar{b}\bar{c} + \bar{a}\bar{b}c + \bar{a}b\bar{c}$

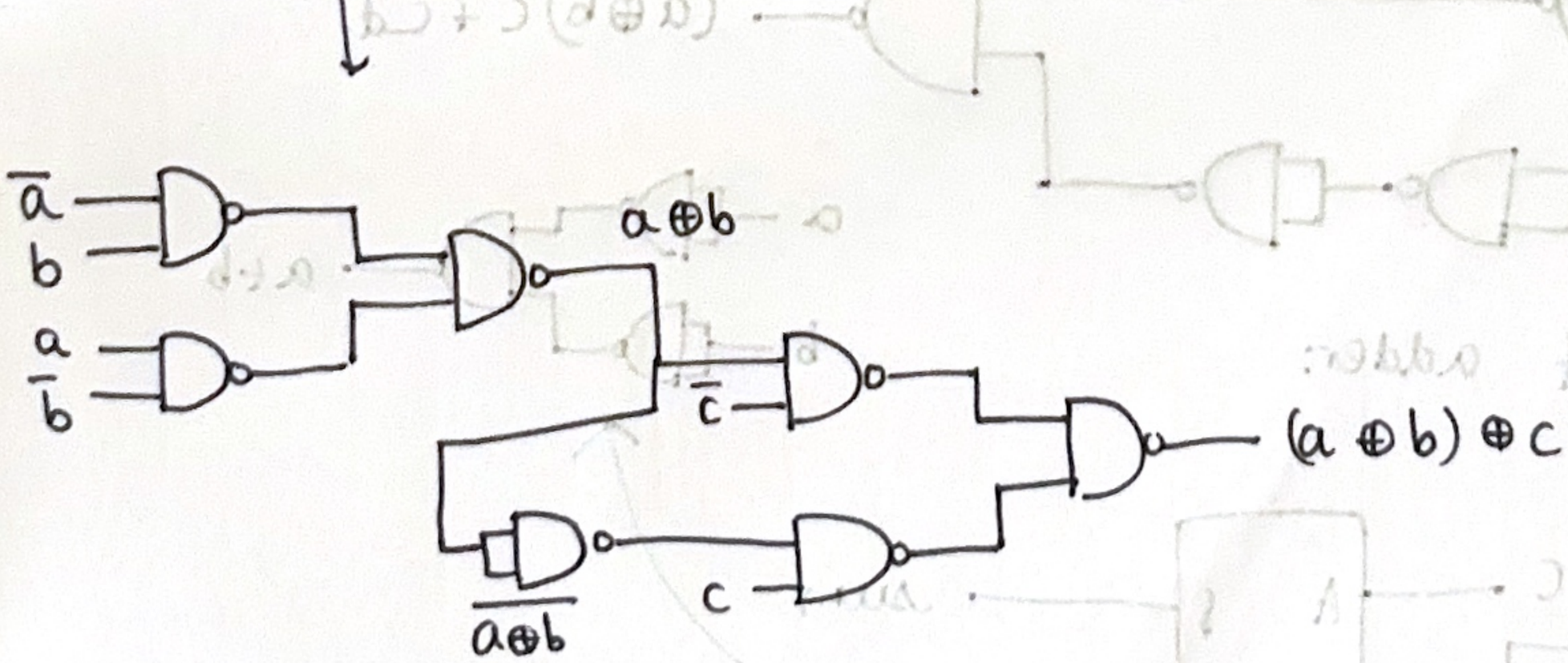
carry = $abc + ab\bar{c} + a\bar{b}c + \bar{a}bc$



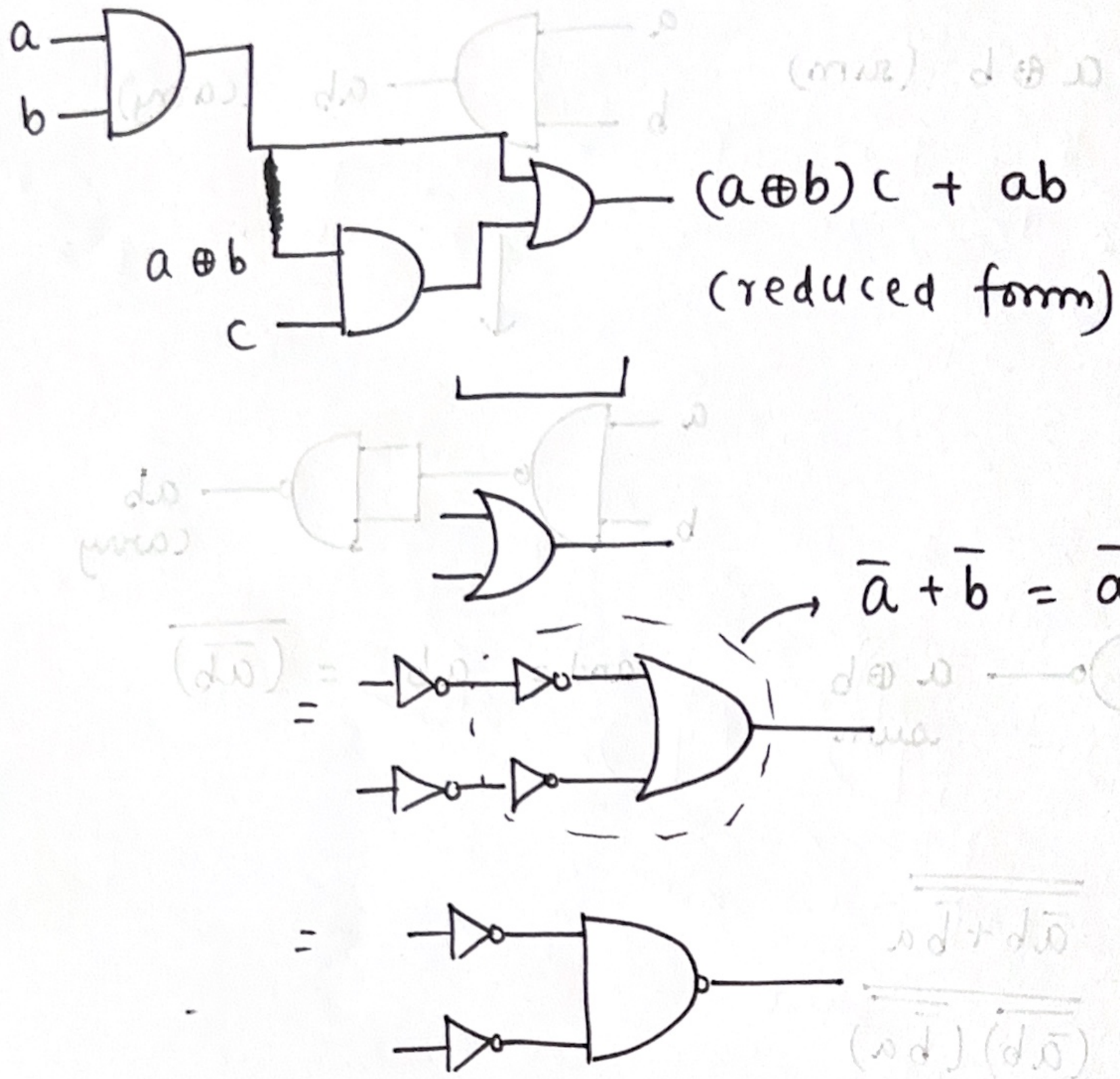
sum: ~~a⊗b⊗c~~ $a \oplus b \oplus c$:



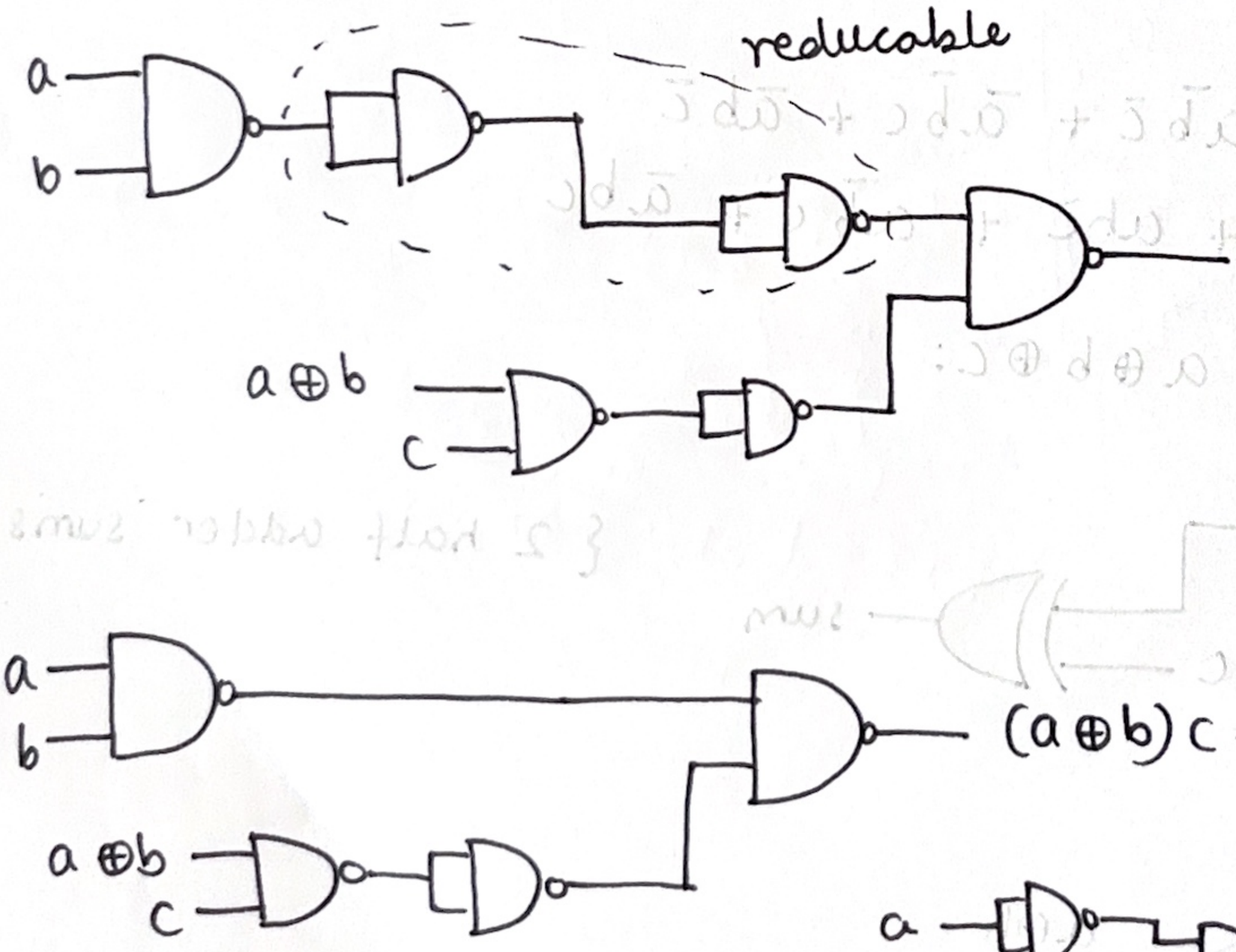
{ 2 half adder sums }



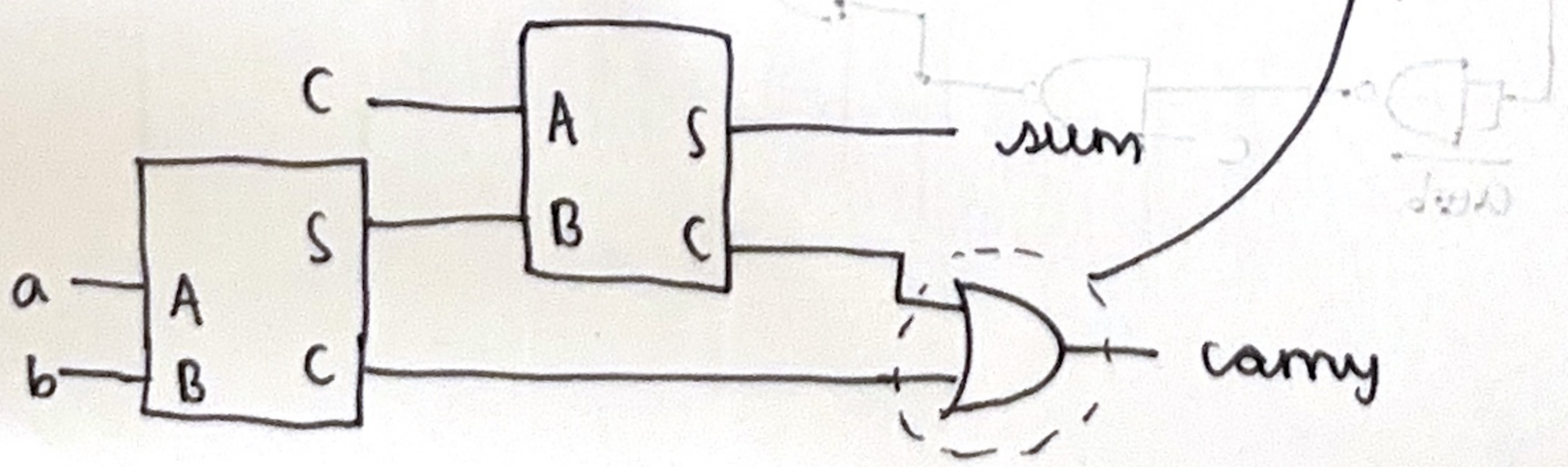
carry:



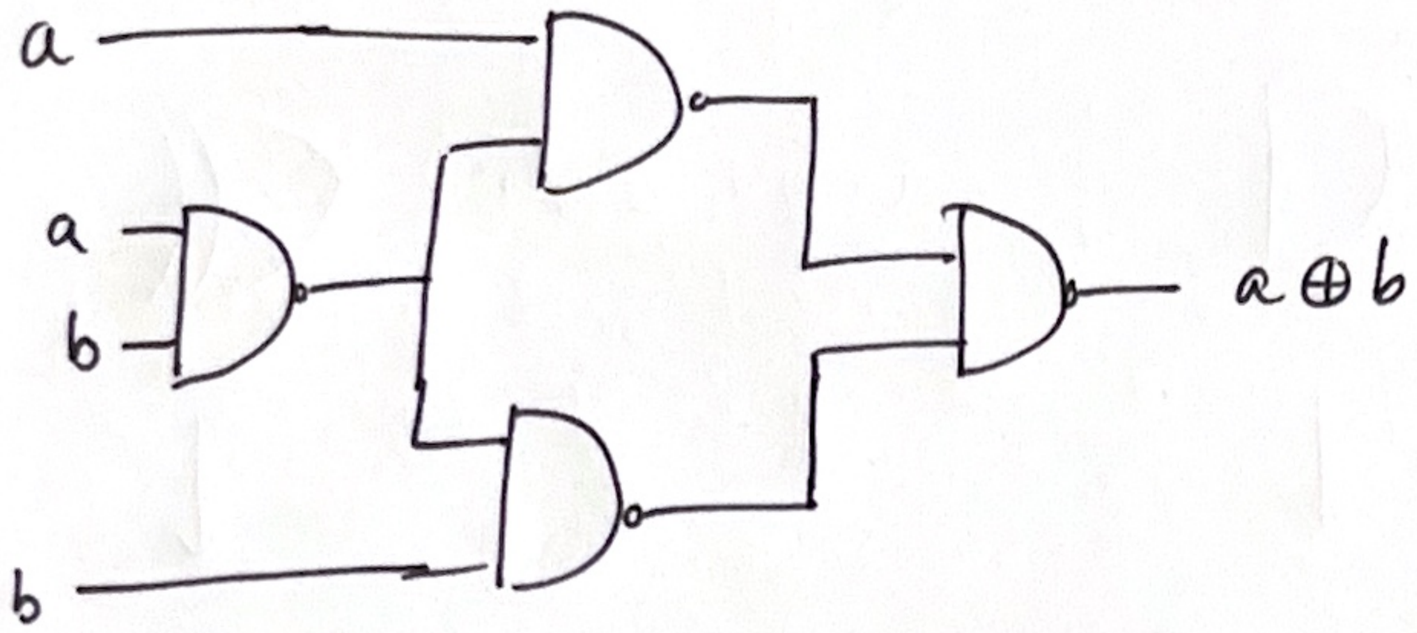
∴



Using half adder:

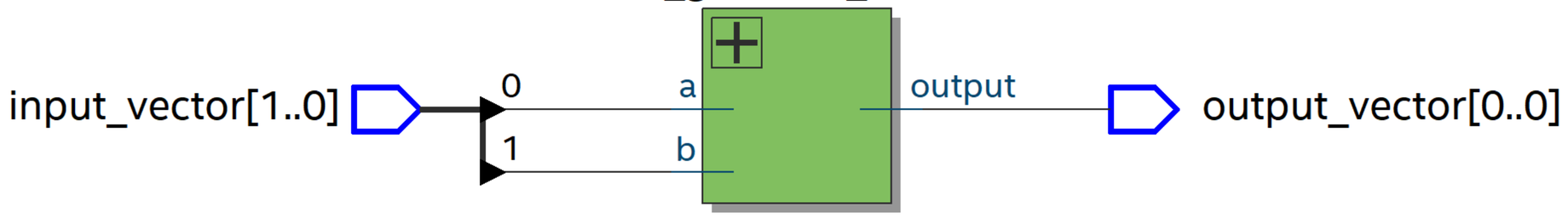


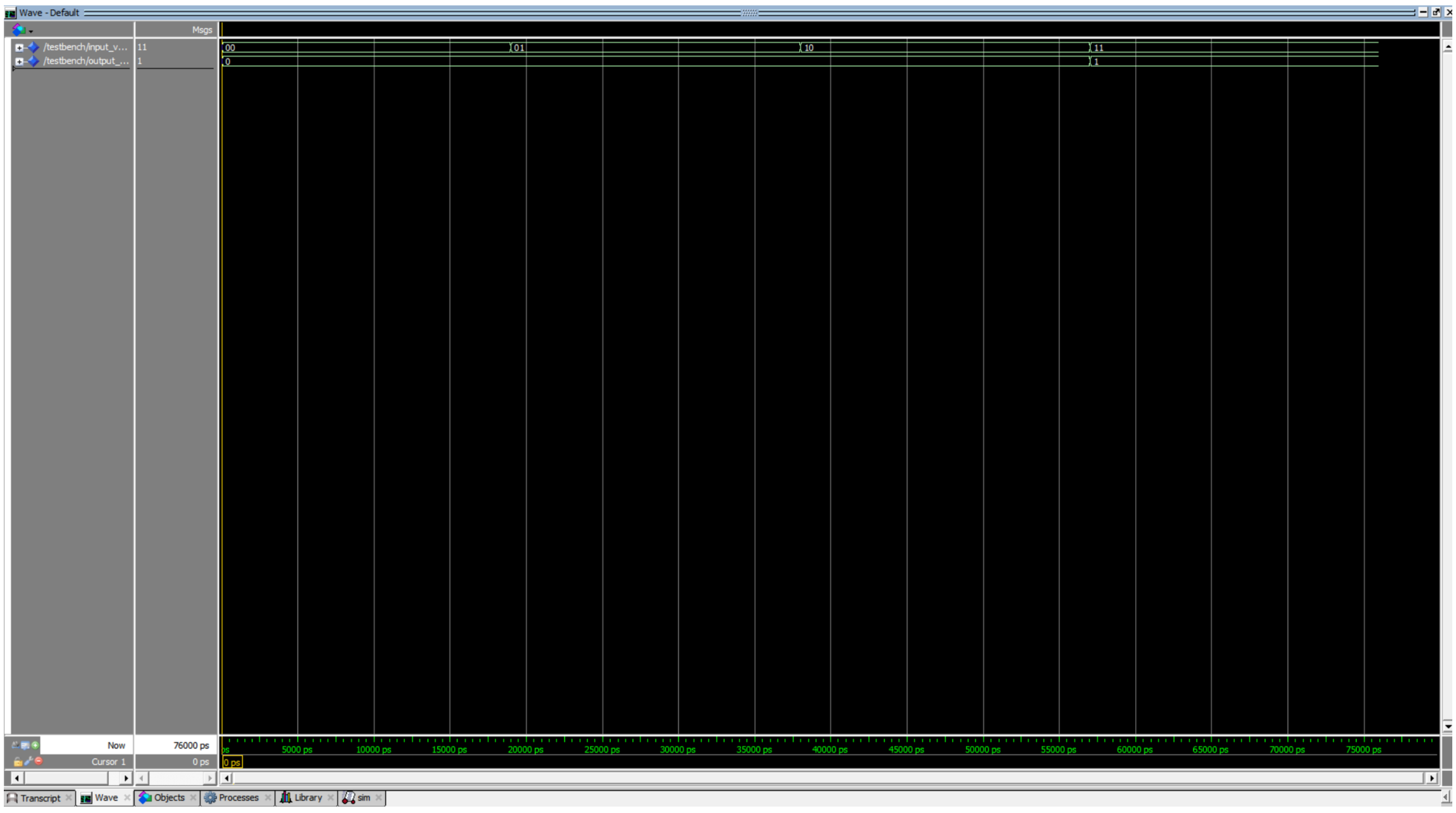
XOR gate using NAND gate:



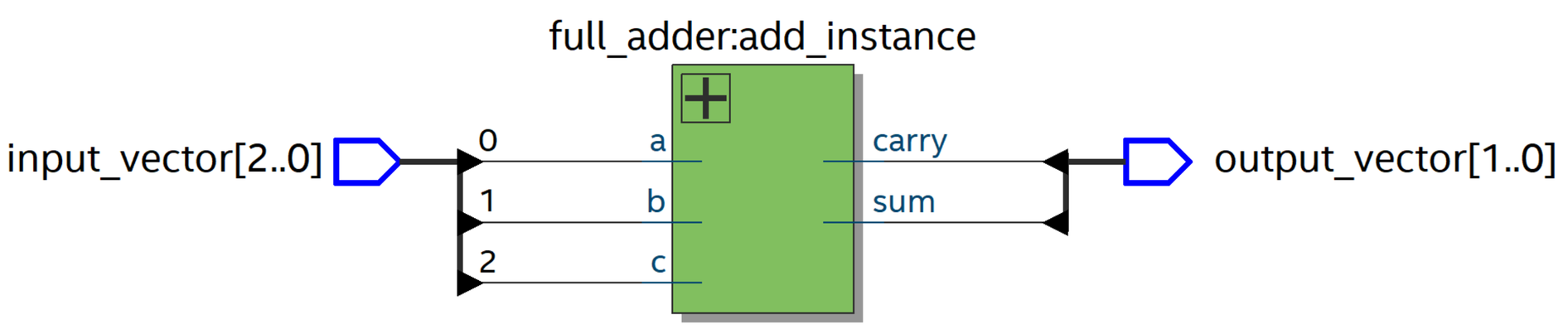
M. Indumathi
7/08/2015.

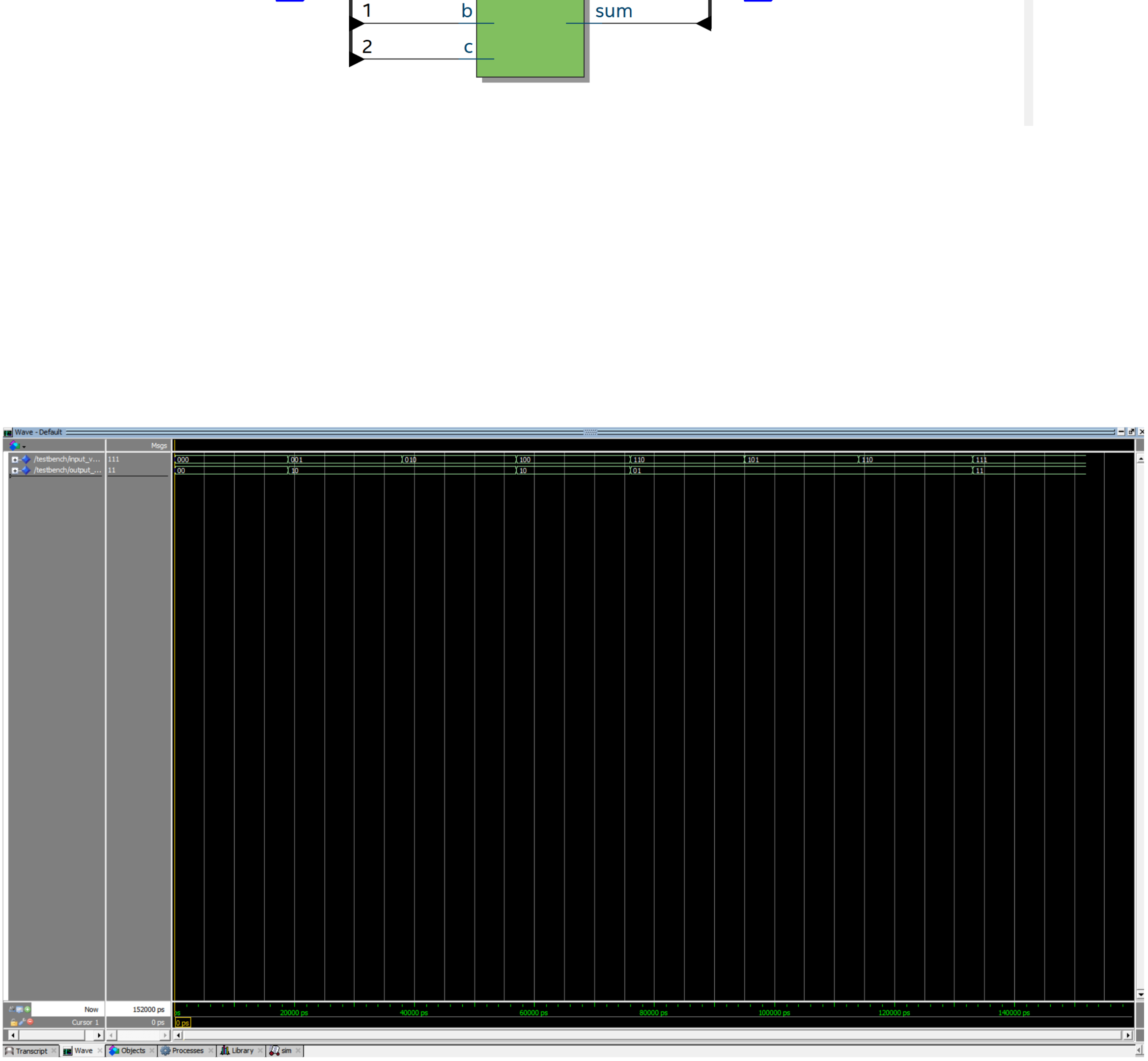
And Gate


nand_gate:add_instance
input_vector[1..0]
0
1
a
b
output
output_vector[0..0]

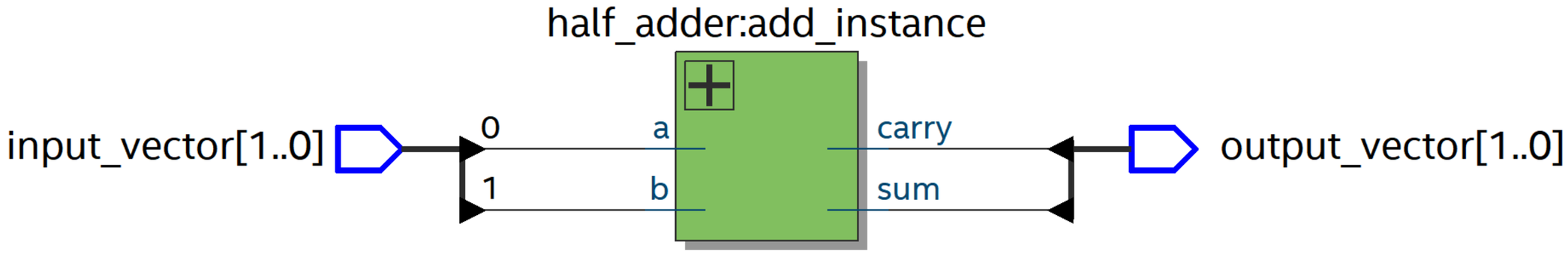

Wave - Default
Msgs
/testbench/input_v...
/testbench/output_...
11
1
00
01
10
11
0
1
Now
76000 ps
Cursor 1
0 ps
5000 ps
10000 ps
15000 ps
20000 ps
25000 ps
30000 ps
35000 ps
40000 ps
45000 ps
50000 ps
55000 ps
60000 ps
65000 ps
70000 ps
75000 ps
Transcript
Wave
Objects
Processes
Library
sim

Full adder


full_adder:add_instance
input_vector[2..0]
0
1
2
a
b
c
carry
sum
output_vector[1..0]

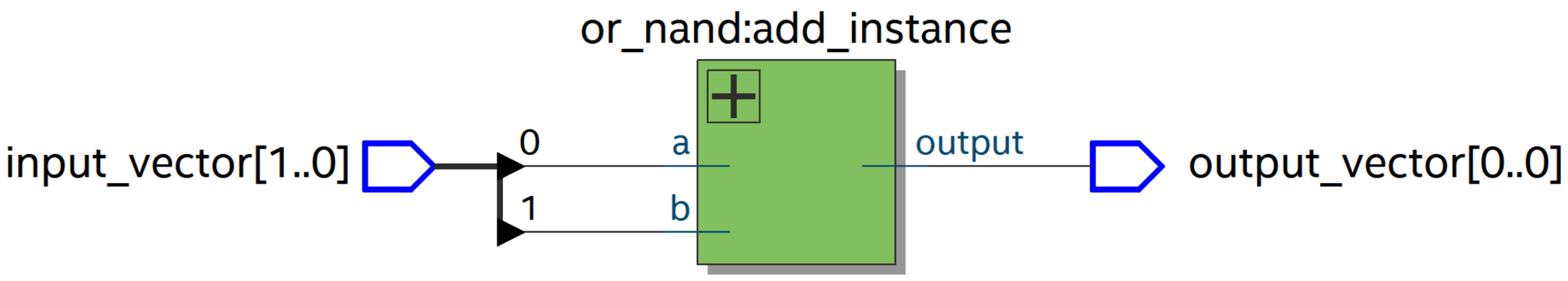

Wave - Default
Msgs
/testbench/input_v...
/testbench/output_...
111
11
000
001
010
100
110
101
110
111
00
10
10
01
11
Now
152000 ps
Cursor 1
0 ps
20000 ps
40000 ps
60000 ps
80000 ps
100000 ps
120000 ps
140000 ps
Transcript
Wave
Objects
Processes
Library
sim

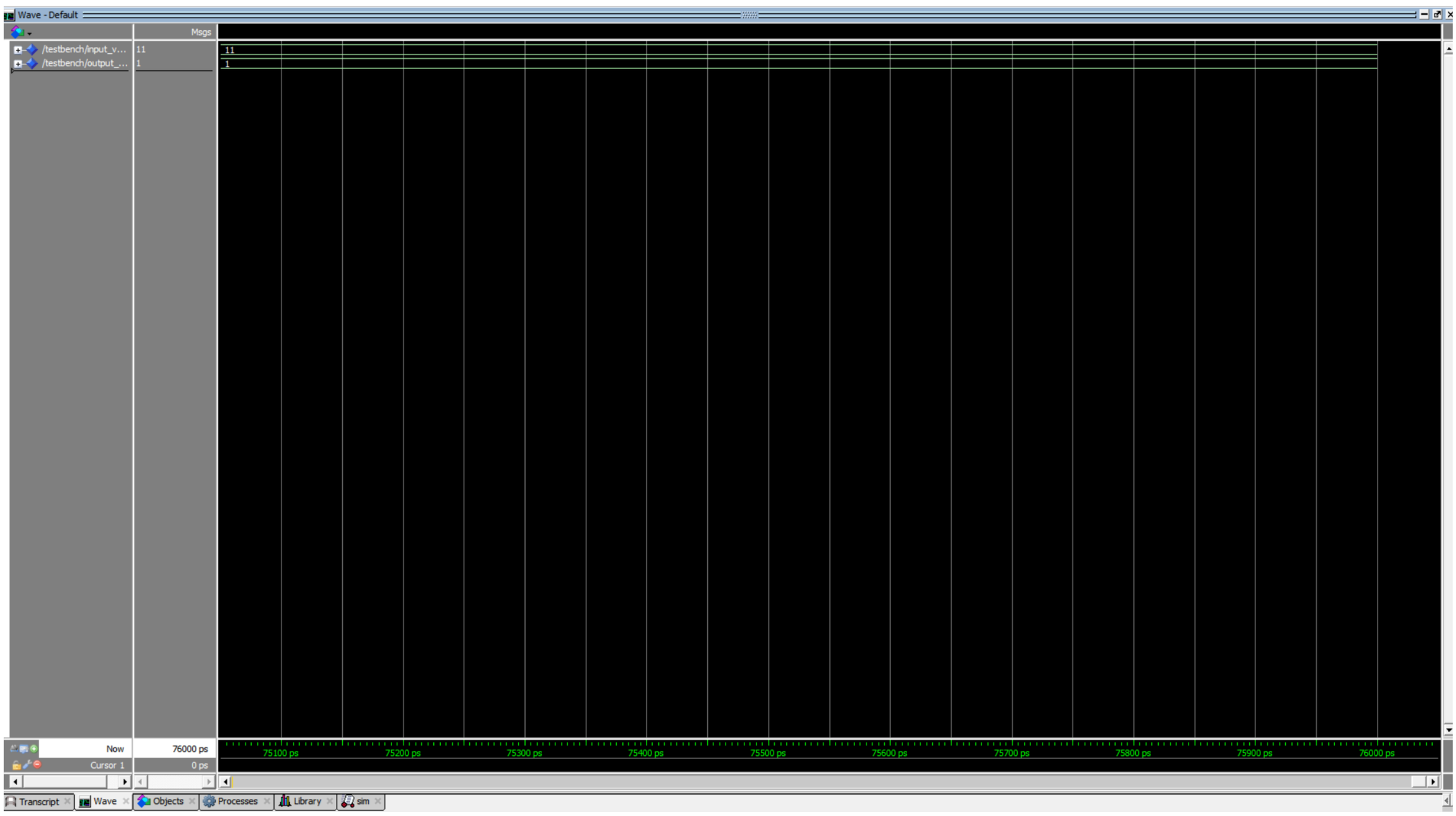
Half adder


half_adder:add_instance
input_vector[1..0]
0
1
a
b
carry
sum
output_vector[1..0]

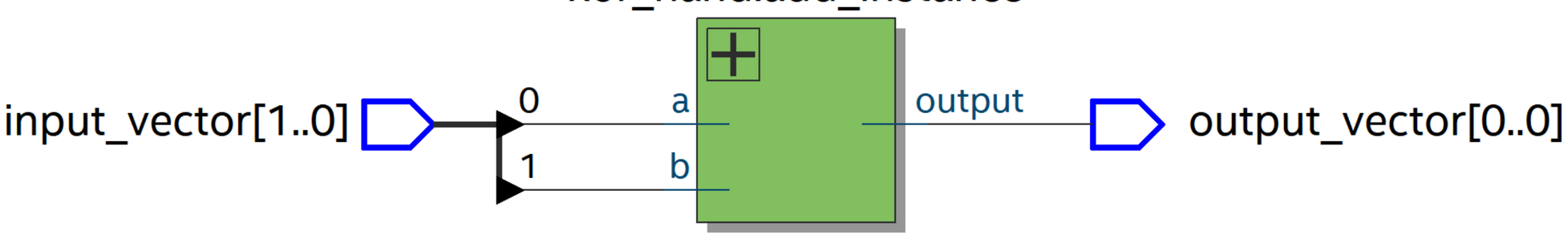
Wave - Default
Zoom In (I)
Msgs
/testbench/input_v...
/testbench/output_...
11
01
00
01
10
00
10
01
Now
76000 ps
Cursor 1
0 ps
0 ps
5000 ps
10000 ps
15000 ps
20000 ps
25000 ps
30000 ps
35000 ps
40000 ps
45000 ps
50000 ps
55000 ps
60000 ps
65000 ps
70000 ps
75000 ps
Transcript
Wave
Objects
Processes
Library
sim

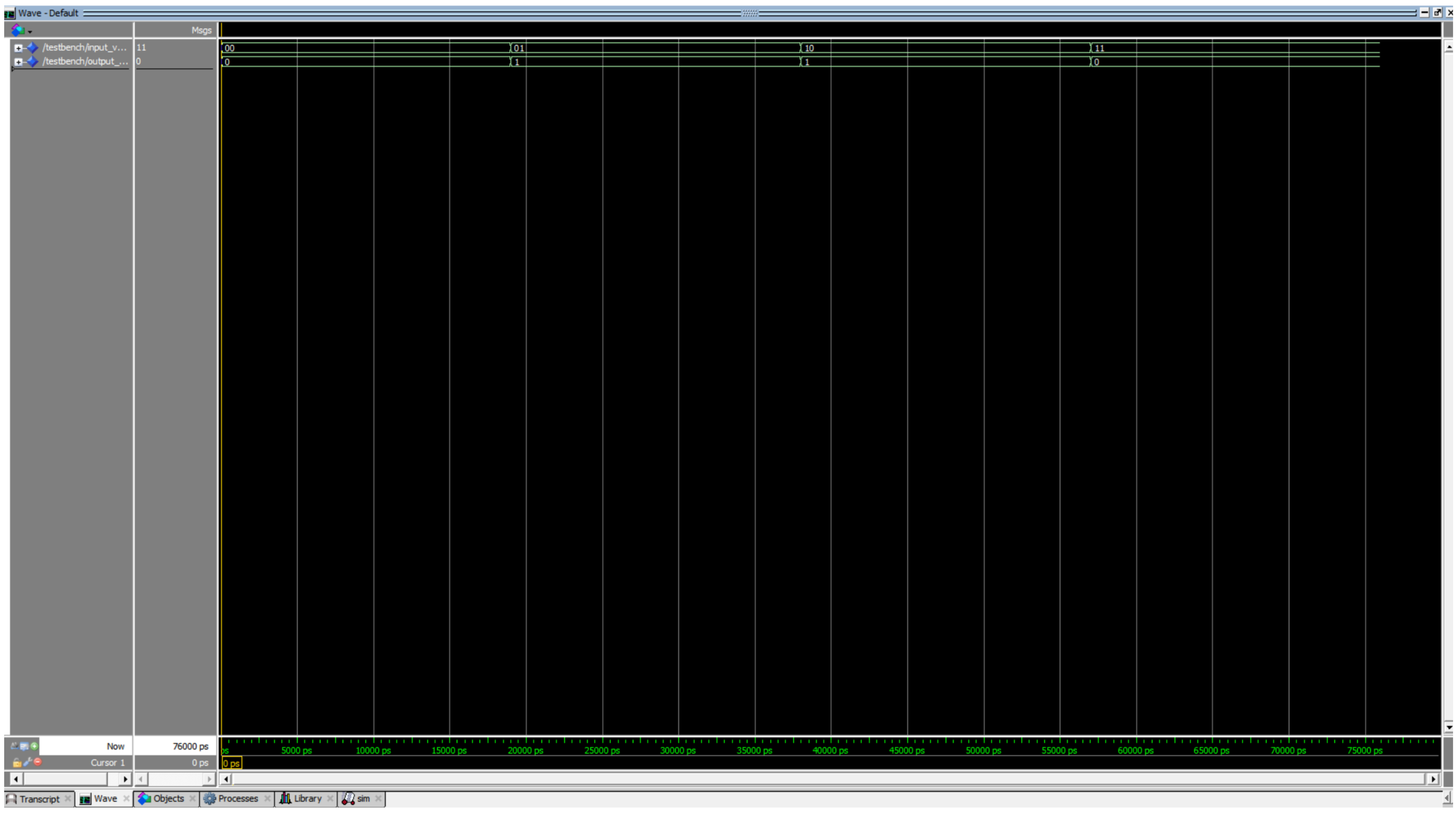
Or gate


or_nand:add_instance
input_vector[1..0]
0
1
a
b
output
output_vector[0..0]


Wave - Default
Msgs
/testbench/input_v...
/testbench/output_...
11
1
11
1
Now
76000 ps
Cursor 1
0 ps
75100 ps
75200 ps
75300 ps
75400 ps
75500 ps
75600 ps
75700 ps
75800 ps
75900 ps
76000 ps
Transcript
Wave
Objects
Processes
Library
sim

Xor gate


xor_nand:add_instance
input_vector[1..0]
0
1
a
b
output
output_vector[0..0]


Wave - Default
Msgs
/testbench/input_v...
/testbench/output_...
11
0
00
01
10
11
0
1
1
0
Now
76000 ps
Cursor 1
0 ps
0 ps
5000 ps
10000 ps
15000 ps
20000 ps
25000 ps
30000 ps
35000 ps
40000 ps
45000 ps
50000 ps
55000 ps
60000 ps
65000 ps
70000 ps
75000 ps
Transcript
Wave
Objects
Processes
Library
sim