Computer Organisation and Architecture Lab

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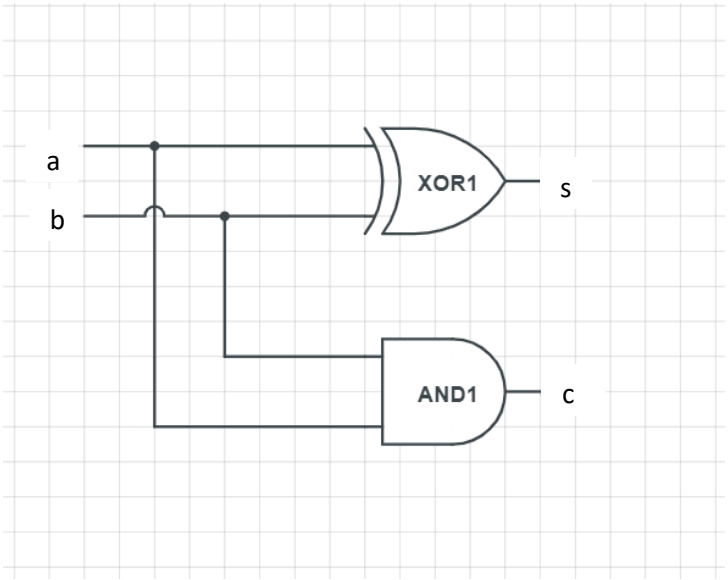
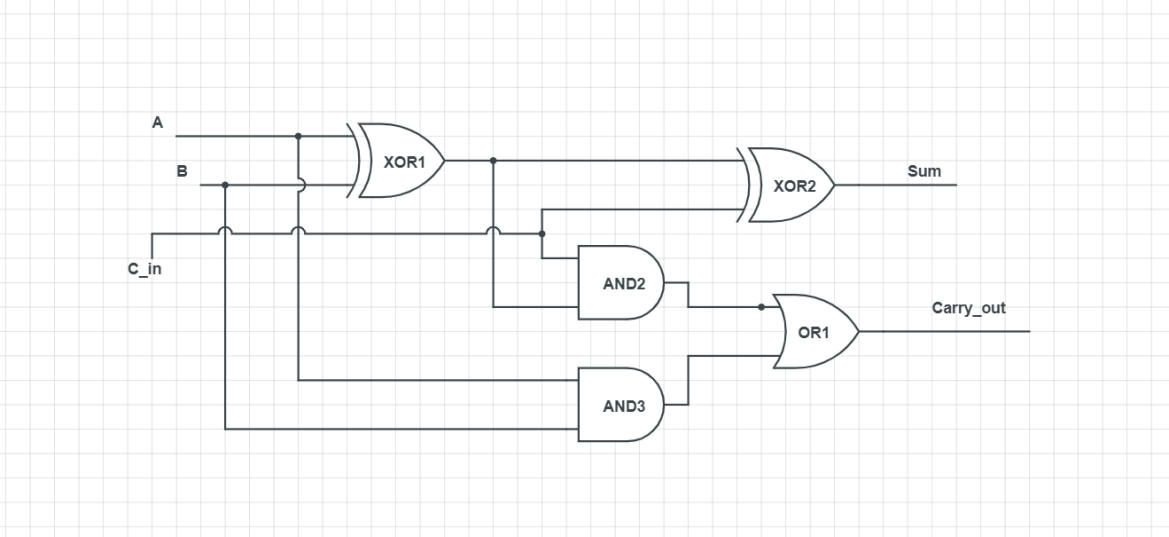
Q1) RCA using Verilog

i.) Half Adder



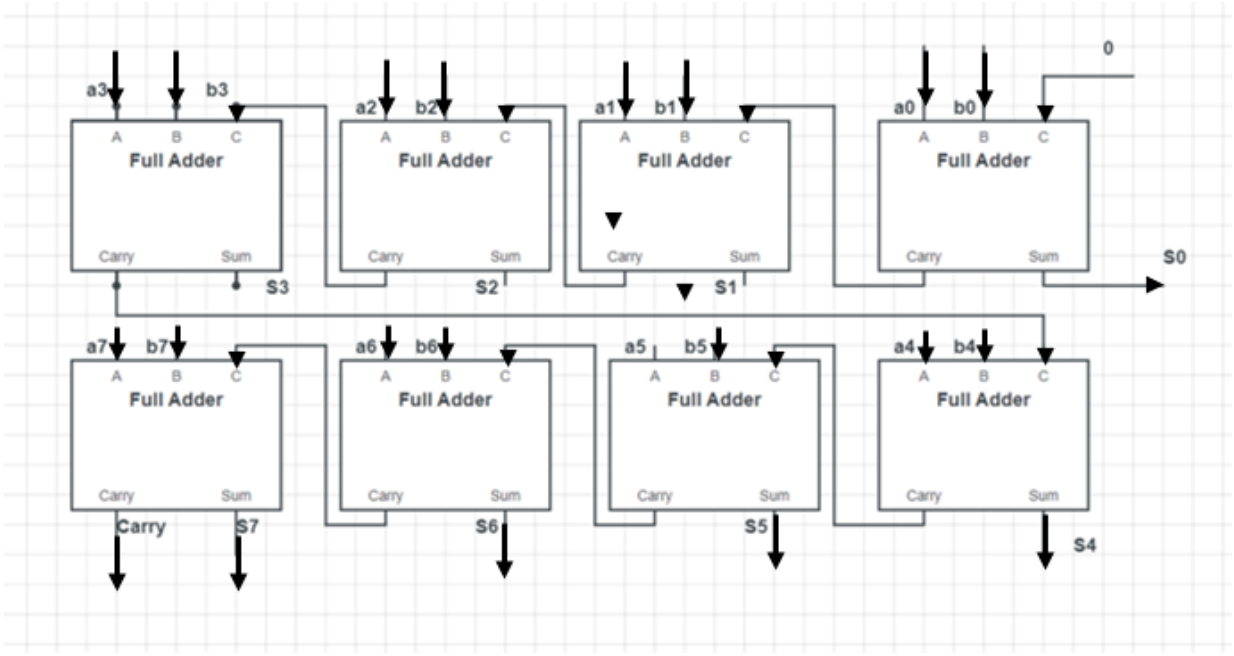
Truth Table of a Half Adder			
Input		Output	
A	b	s (Sum)	c (carry)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

ii.) Full Adder

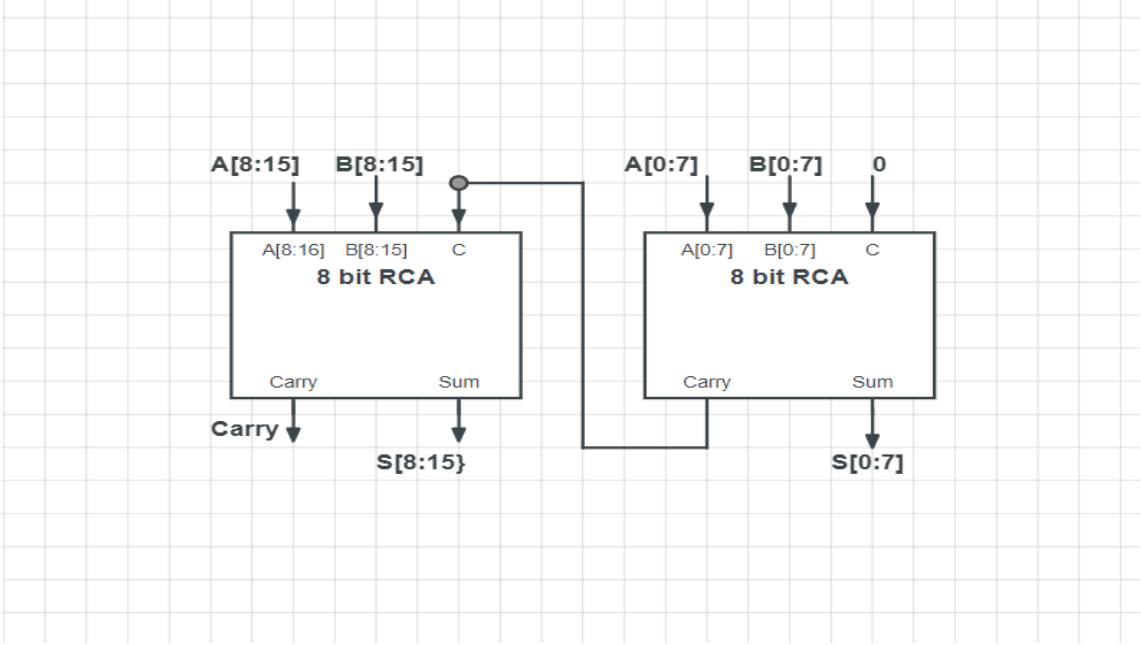


Truth Table of a Full Adder				
Input			Output	
A	B	C_in	Sum	Carry_out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

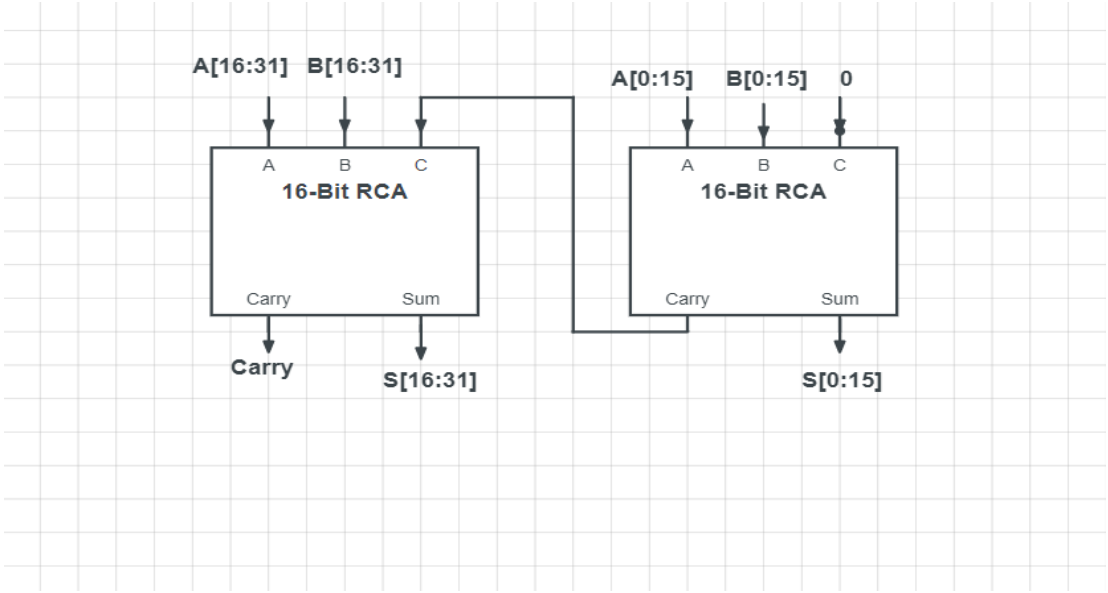
iii.) 8 – Bit Ripple Carry Adder



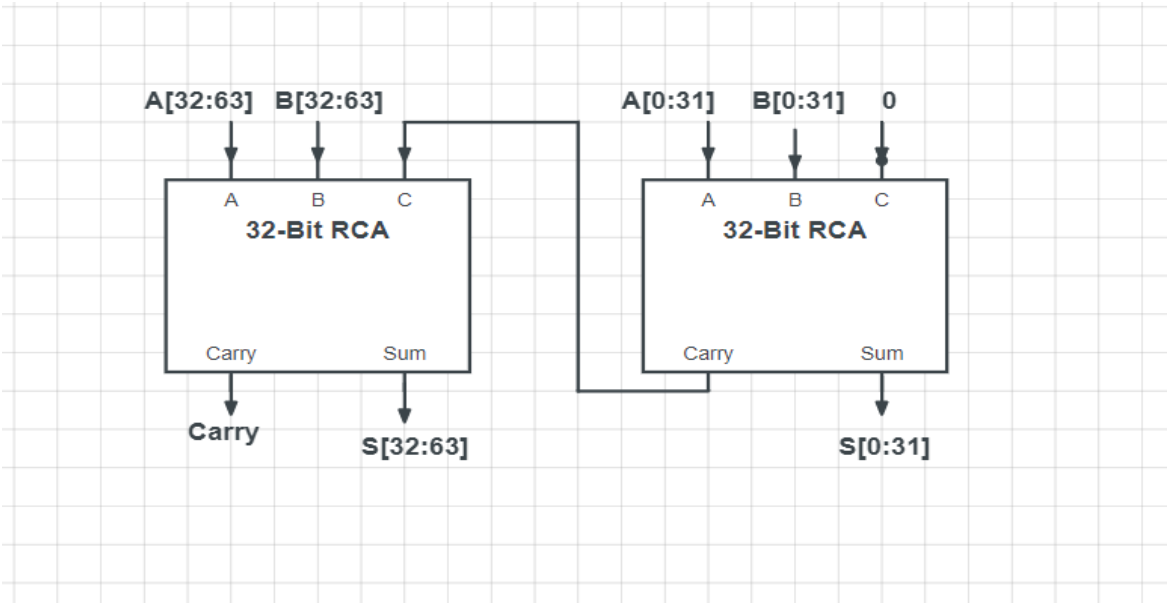
iv.) 16- Bit RCA



v.) 32-Bit RCA



vi.) 64- Bit RCA



Question: How can you use the above circuit, to compute the difference between two n-bit numbers?

Answer: Ripple Carry adder with input a and b and initial carry bit c_0 actually computes the binary sum of a and b, also adding c_0 to the LSB of the sum. Thus, c_0 is set to 0 so that RCA adds a and b bitwise and output the result.

For finding difference between two number a and b i.e., a-b we will convert the subtraction problem into addition problem:

i.e., a – b = a + (-b) where (-b) is the 2's complement of b.

we know that 2's complement of any number can be calculated by computing 1's complement of that number and then adding 1 to the LSB of the 1's complement. That is, (-b) = (~b) + 1 where (~b) is the 1's complement of b

let a = 100 (4) and b = 010 (2) and n=3

therefore, a – b = 100 – 010

-b = 101 (= ~b) + 1 = 110

a – b = 100 + (110) = 010 (carry_out = 1)

To calculate 1's complement of a number, we simply have to flip all the bits of that number. That is, we pass every bit of b to a NOT gate to flip the bits of the b. Therefore, whenever we need to calculate difference between a and b i.e., a-b we would first calculate 1's compliment of b by taking NOT of every bit of b with 1. Since we also need to add 1 to the 1's complement calculated, we would pass this 1 as c_0 to the RCA. Therefore, upon passing a, (~b) and 1 as input to RCA, the n-bit RCA can calculate the difference between a and b.

Synthesis Report

Circuit	Delay (in ns)	Logic Levels	Number of Slice LUTs	Number of bonded IOBs
Half Adder	1.066	3	2	4
Full Adder	1.246	3	2	5
8-Bit RCA	3.471	6	12	26
16-Bit RCA	6.167	10	24	50
32-Bit RCA	11.559	18	48	98
64- Bit RCA	22.343	34	96	194