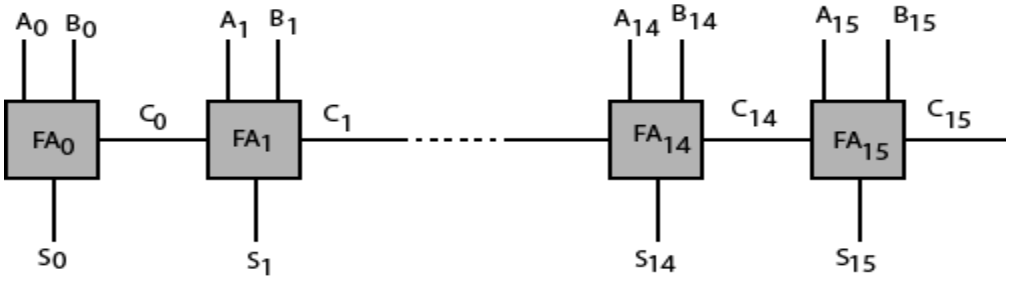
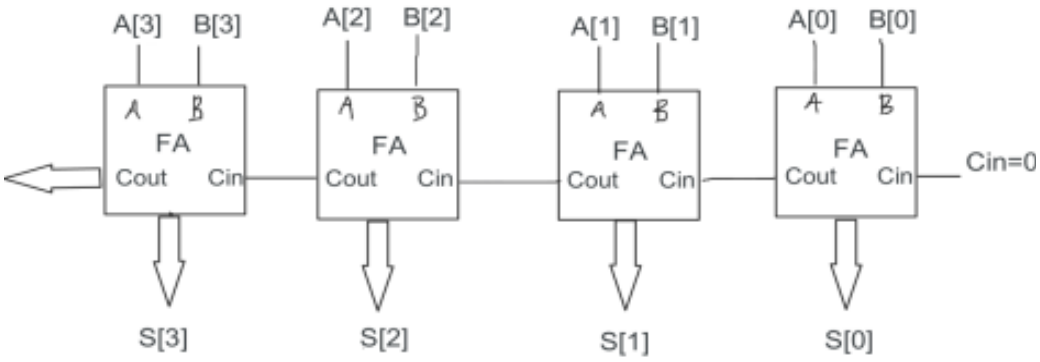
Tutorial 4
Computer Organisation

1. A 16-bit Ripple carry adder (RCA) is made up of 16 identical full adders (FA), as shown in the figure below. The carry-propagation of each FA is 13 ns and the sum-propagation delay of each FA is 16ns. The worst-case delay (in ns) of this 16-bit adder will be?

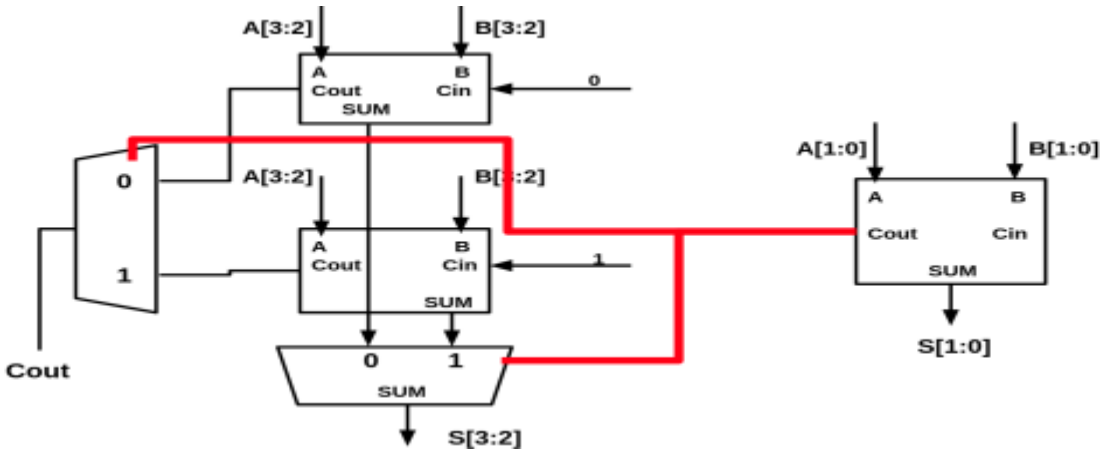


2. Suppose the value of A[3:0] = 0011 and B[3:0] = 0001. Write down 0 or 1 to denote the state of each wire in the following Ripple carry Adder (RCA) and Carry Select Adder (CSA) circuits:

a.) RCA



b.) CSA



3. Compare Carry Select Adder (CSA) with Ripple Carry Adder (RCA) by filling the following table with faster/slower in the performance column and larger/smaller in the resource utilization column. Also, explain your answer with valid reasoning

Adder Type	Performance	Resource Utilisation
CSA		
RCA		

4. Design a 4- bit Ripple carry adder that can perform addition and subtraction operations. Explain how it work.

5. We need to perform the following operations, where numbers are represented in 2's complement:

a) -87 + 256

b) 490 + 22

For each case:

1. Determine the minimum number of bits required to represent both summands. You might need to sign-extend one of the summands, since for proper summation, both summands must have the same number of bits.

2. Perform the binary addition in 2's complement arithmetic. The result must have the same number of bits as the summands.

3. Determine whether there is overflow.

4. If there was an overflow, then redo the computation by sign extending both summands.

5. If we want to avoid overflow, what is the minimum number of bits required to represent both the summands and the result?

6.

(i) For the following values of A and B, compute A+B and A-B. Note that both are denoted using 2's complement notation:

a. A = 0111 and B = 0011

b. A = 1110 and B = 1101

c. A = 1110 and B = 0011

d. A = 0011 and B = 1110

(ii) Propose logical conditions to detect Overflow in 2's Complement Addition and make a suitable table.

7.

(a) Convert the following numbers into binary and write down the first 6 bits after the decimal place:

(i) 0.2
(ii) 0.1
(iii) 0.3

(b) Perform the addition of (i) and (ii) using,
- **(i) First 5-bits after decimal point**
- **(ii) First 6-bits after decimal point**

(c) Compare the results of part (b)'s (i) and (ii) with the first 5-bits and first 6-bits of the (a)-(iii)'s answer respectively. Explain your observations.