Week 4

Design of Full adder

Carry Propagate Adder (CPA)

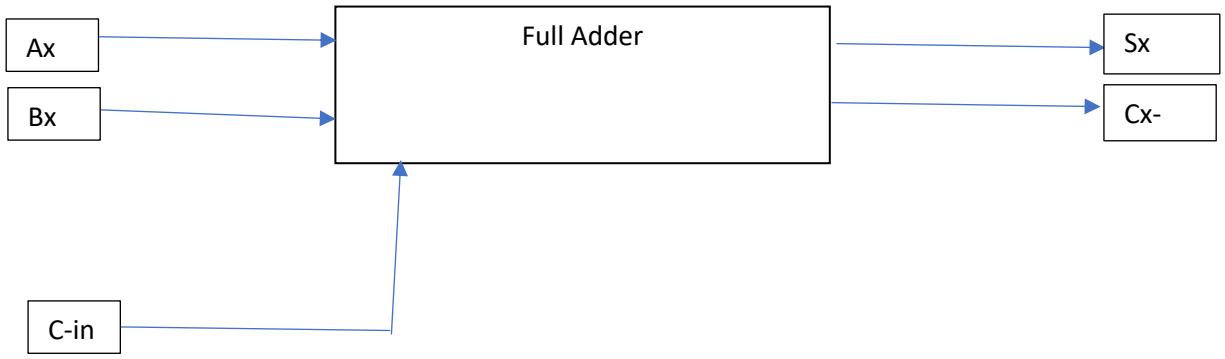
- Full adder is an arithmetic logic unit or circuit to add two single digit numbers with Carry-in.
- It is still combinational circuit with inputs Ax and Bx.
- S = Sum (1bit); C-in = Carry in; C-out = Carry Out.
- Adder is also called Ripple Carry Adder (RCA)
- Simplest circuit for an adder and has longest propagation delay that is proportional to the number of the carry bits
- Equation to estimate the propagation delay of an n-bit CPA. ΔFAC and ΔFAS stand for delta time for carry bit and delta time for sum signal propagation delay of a Full Adder (FA)

$$\Delta CPA(n) = [(n-1) * \Delta FA_C] + \Delta FA_S \quad Eq(2.8)$$

- Using AND/OR/EOR gate, Δ for AND/OR gate is = 0.1 ns and Δ for EOR = 0.3ns, ΔFAC = 0.2ns and ΔFAS = 0.3ns, as per Eq(2.8)
    - For 8 bit CPA (n=8), the equation to calculate propagation delay is as follows:

$$\Delta CPA(n) = (n -1)(0.2ns) + 0.3ns$$

Block Diagram of Full adder

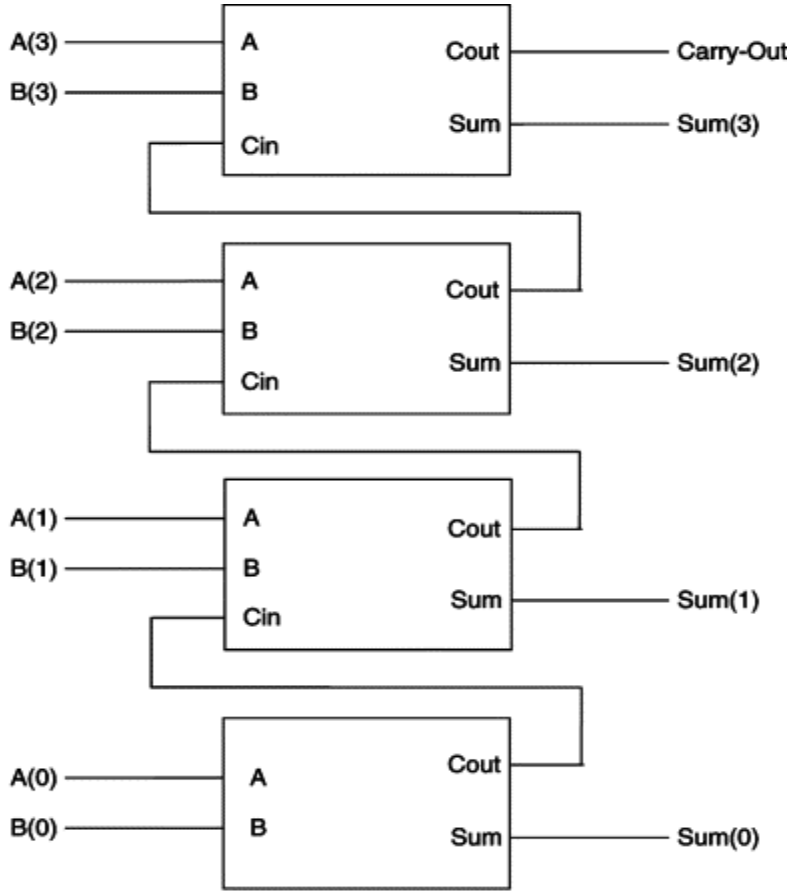


Design of Full Adder

- With three inputs and 2 outputs
- **Full adder Truth Table**

Inputs			Outputs	
A	B	C – IN	Sum	C - 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

Schematic of a 4 bit Cary Propagate Adder (CPA)



4-bit binary addition

```
                A(3)    A(2)    A(1)    A(0)
                B(3)    B(2)    B(1)    B(0)    +
-------------------------------------------------
 Carry-Out   Sum(3)  Sum(2)  Sum(1)  Sum(0)
-------------------------------------------------
```

4-bit binary addition

```
                A(3)    A(2)    A(1)    A(0)
                B(3)    B(2)    B(1)    B(0)    +
-------------------------------------------------
 Carry-Out   Sum(3)   Sum(2)   Sum(1)   Sum(0)
-------------------------------------------------
```

Binary Addition review:

0 + 0 = 0; 0 + 1 = 1; 1 + 0 = 1;
1 + 1 = 10

A	B	S	Cout
0	0	0	
0	1	1	
1	0	1	
1	1	0	1

A = 0111
B = 1111

Inputs			**Output**	
A[i}	B[i}	C-in	S	C out
1	1	0	0	1
1	1	1	1	1
1	1	1	1	1
0	1	1	0	1

Week 5

Multiplexer (Mux)

- Selecting of data or information is a critical function in a digital systems and computers
- A Multiplexer (Mux for short) is a digital switch; Mux is a circuit used to select and route any of the several inputs to a output signal
- Mux is a combinational circuit. it has the following:
    - 2^n inputs
    - N control inputs
    - One set of outputs
- For a multiplexer, the value of the control inputs (selector signals) determines the data input that is selected
- Multiplexer means many into one. a simple example of a non-digital circuit of a mux is a single pole multi-position switch. Multi-position switches are widely used in many electronics circuit, however, circuits that operate at high speed require the multiplexer to be automatically selected.
- Example: 1 bit , 2 to 1 Mux
    - X and Y are the inputs
    - S is the selector signal
    - r is the output

Week 5

Design of a 1 bit, 2 to 1 mux

1. Block diagram of 1 bit, 2 to 1 mux