4 bit Subtractor

> Full subtractor:
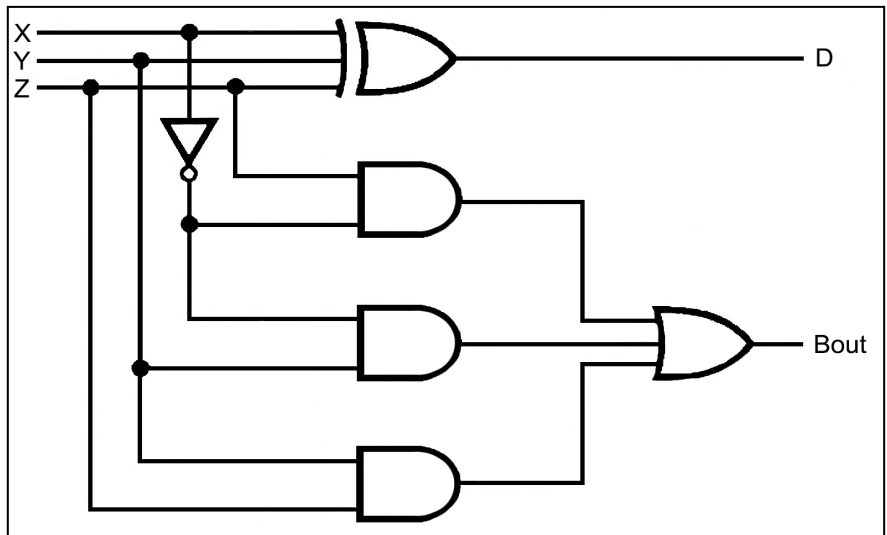
D = X xor Y xor Z

Bout/borrow = X'Z or X'Y or YZ

Truth Table

X	Y	Z	D	Bout / borrow
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Full subtractor Circuit:

To create a 4-bit subtractor, a connection of 4 complete subtractors is needed. Each subtractor performs a two-bit subtraction taking into account the borrowing of the previous least significant bit. The subtractors take inputs A0-B0, A1-B1, A2-B3, A3-B0 respectively, with subtractor 0 taking Z as its third input, and each subsequent subtractor taking the borrowing of the previous subtractor as its third input and the total difference to be induced with the diff.

> 4 bit Subtractor circuit:
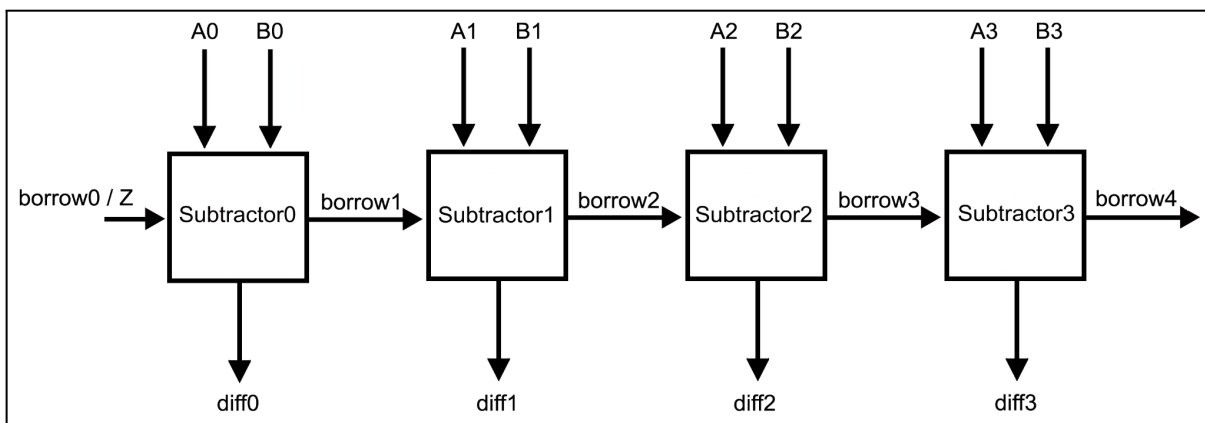
> Demonstration with 5 subtractions:

0ns : 0100 - 0001 with expected difference = 0011
10ns: 1011 - 1001 with expected difference = 0010
20ns: 1111 - 1111 with expected difference = 0000
30ns: 1110 - 0101 with expected difference = 1001
40ns: 1001 - 0010 with expected difference = 0111

In all 3 circuits/models the results of the simulation are as follows:

Run Time: 50ns

	0	10,000	20,000	30,000	40,000
tb_A[3:0]	100	1011	1111	1110	1001
tb_B[3:0]	1	1001	1111	101	10
tb_diff[3:0]	11	10	0	1001	111
tb_borrow[4:0]	110	0		10	1100

*The testbench remains the same for all three models.