



**BIRZEIT UNIVERSITY**

**Faculty of Engineering and Technology Electrical and**

**Computer Engineering Department**

**Digital Project**

**BCD adder—subtractor circuit**

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**Section: 7**

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## **Abstract:**

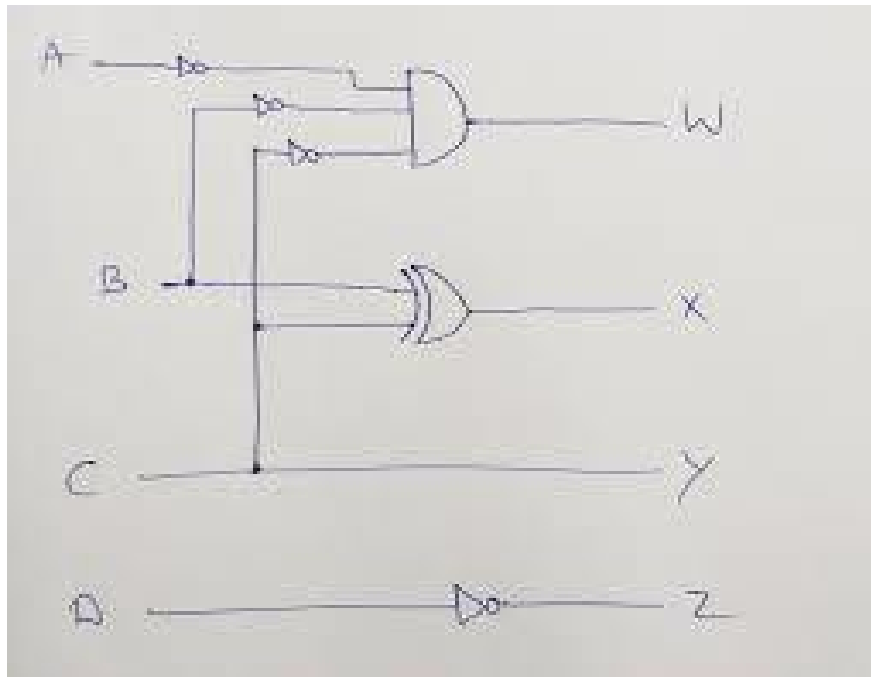
The aim of this project is to implement a BCD adder—subtractor circuit using Verilog HDL.

# Components:

## 1- 9's complement of a BCD digit:

The nines' complement of a decimal digit is the number that must be added to it to produce 9. For example, the complement of 3 is 6, the complement of 7 is 2 and so on.

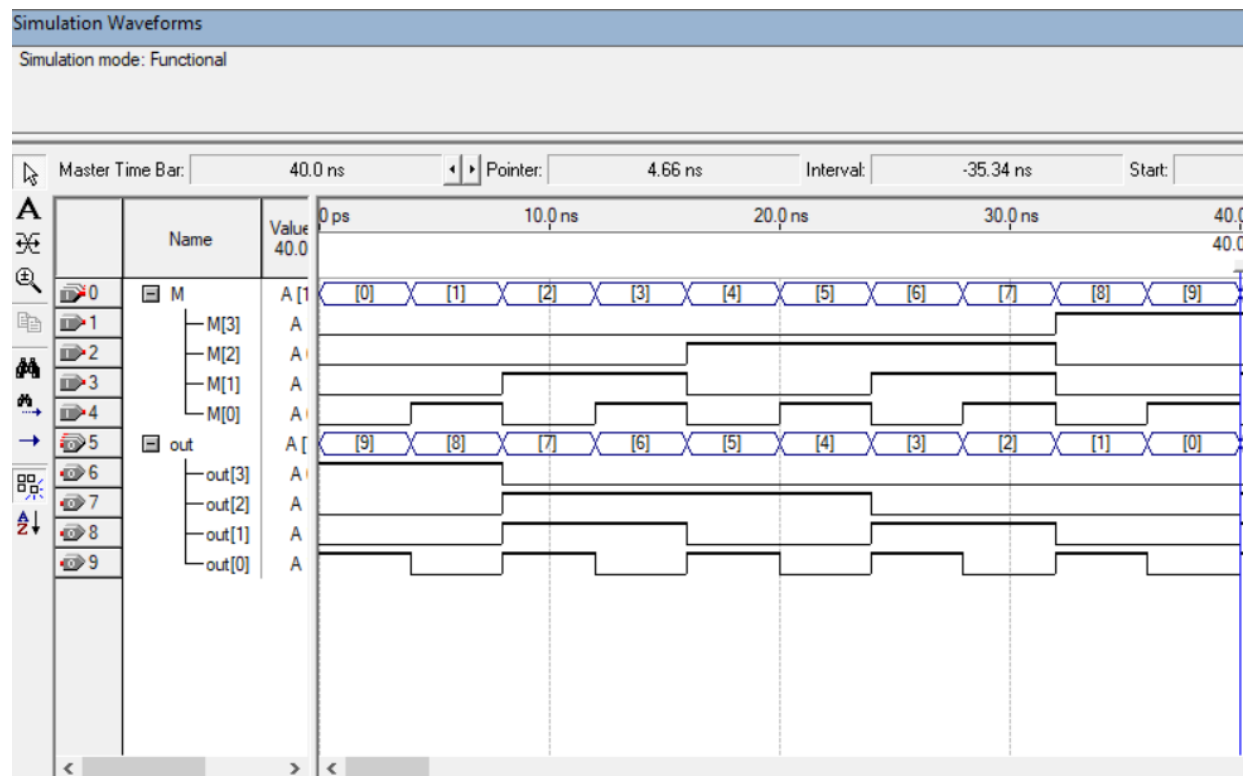
\*The circuit design:



\*The data flow module:

```
1 // The design of the 9's complement using a data flow model
2 //Author : Lana Hamayel
3 module Nines_complement_of_BCD_digit (M,out);
4 // define the inputs and the outputs
5 input [3:0] M;
6 output [3:0] out;
7
8 assign out[3] = !M[3] && !M[2] && !M[1];
9 assign out[2] = M[2] ^ M[1];
10 assign out[1] = M[1];
11 assign out[0] = !M[0];
12 endmodule
```

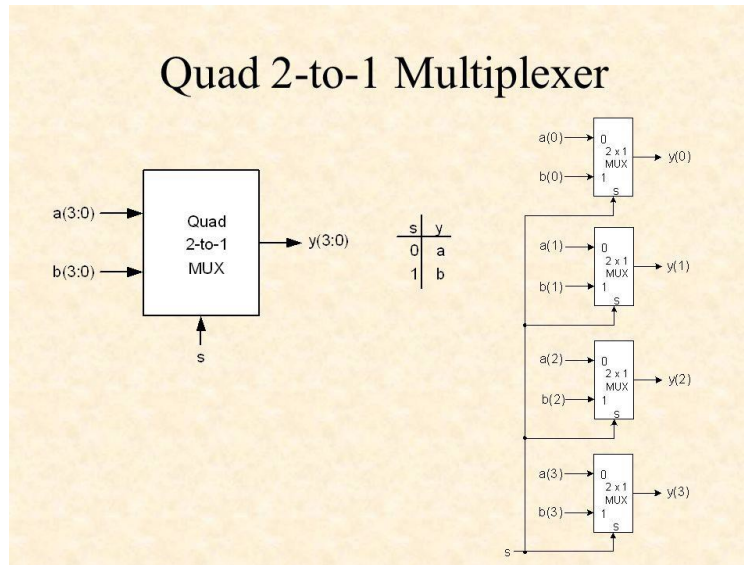
\* The wave form:



## 2- Quadruple 2X1 multiplexer:

It's is a combinational circuit which takes n inputs and produce only one output.

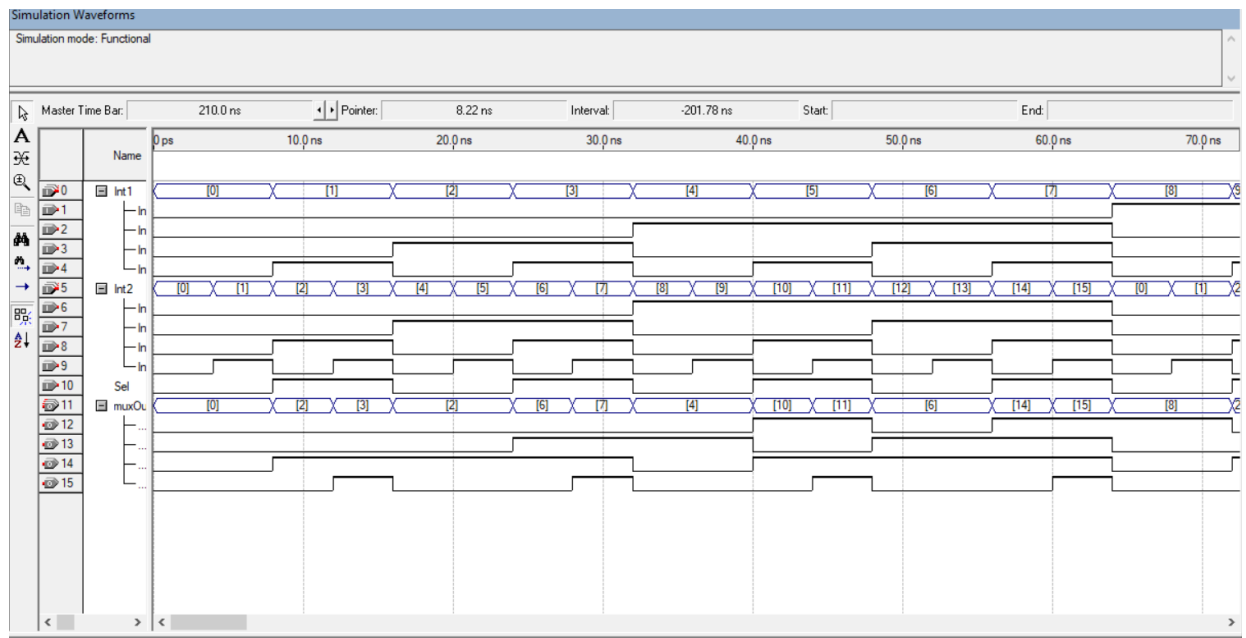
\*The circuit design:



\*The behavioral module:

```
1 //The module of the Quadruple_2x1_MUX
2 //Author : Lana Hamayel
3 module Quadruple_2x1_MUX ( Int1, Int2, muxOut, Sel);
4 // define the inputs and the outputs
5 input Sel;
6 input [3:0] Int1, Int2;
7 output [3:0] muxOut;
8 reg [3:0] muxOut;
9 always @ ( Int1 or Int2 or Sel )
10 if (Sel == 0)
11 muxOut = Int1;
12 else muxOut = Int2;
13 endmodule
14
```

\*The wave form:



### 3- BCD adder:

It's a combinational circuit that is capable of adding two 4-bit words having a BCD (binary-coded decimal) format and representing the decimal sum also the carry that is generated if this sum exceeds a decimal value of 9.

\*The circuit design:

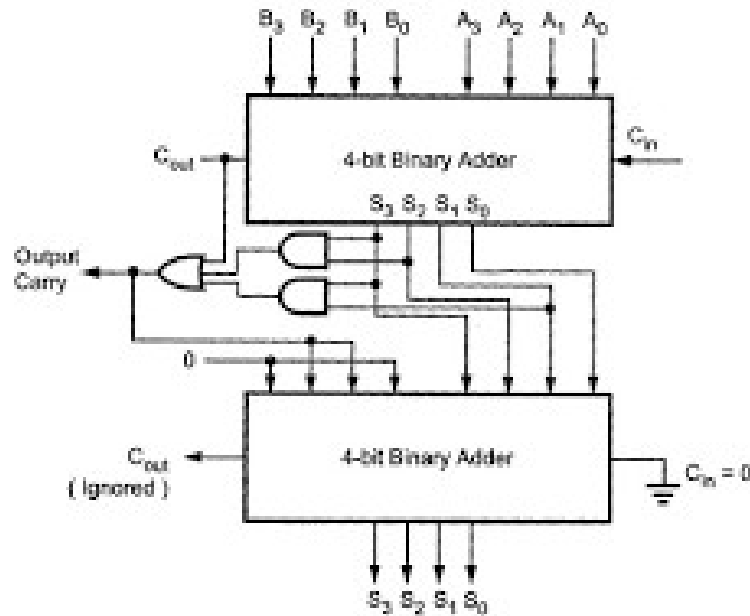
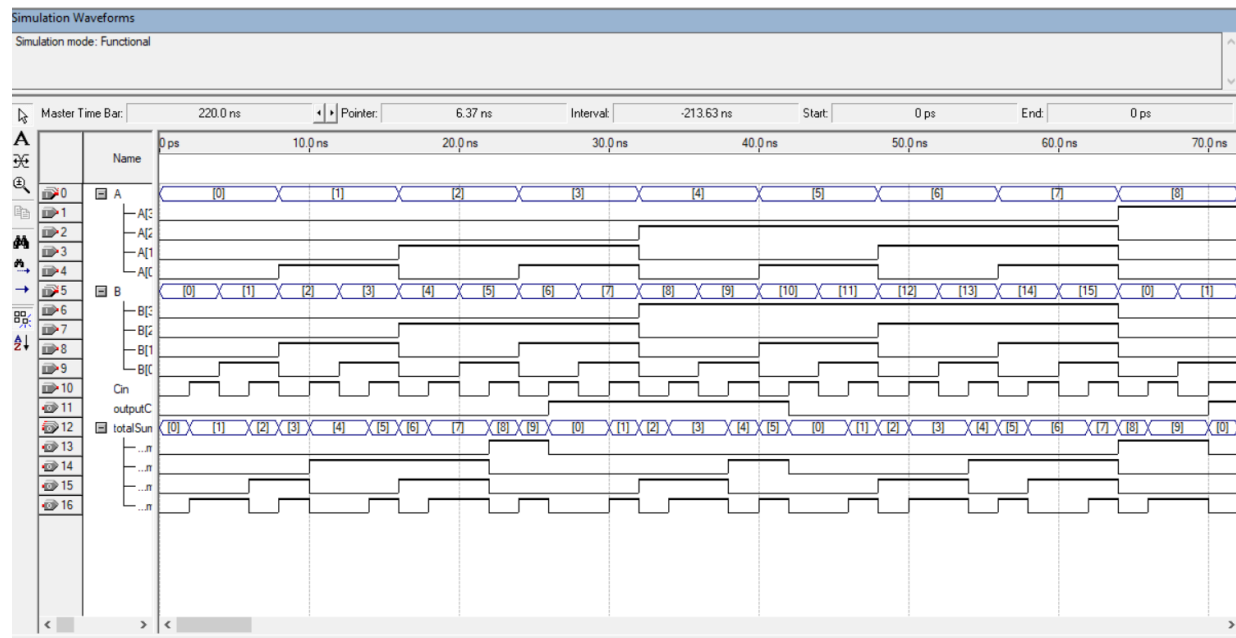


Fig. 3.32 Block diagram of BCD adder

\*The data flow module:

```
1 // The module of the BCD Adder using data flow module
2 //Author : Lana Hamayel
3 module BCD_adder ( A, B, Cin, totalSum, outputCarry);
4 // define the inputs and the outputs
5 input [3:0] A,B;
6 input Cin;
7 output [3:0] totalSum;
8 output outputCarry;
9 wire [3:0] Z,w2;
10 wire w1,K;
11
12 assign {k,Z} = A + B + Cin;
13
14 assign w1 = ( Z[3] && Z[2]) || (Z[1] && Z[3]) ;
15
16 assign outputCarry = w1 || K;
17
18 assign w2 = { 1'b0, outputCarry ,outputCarry, 1'b0 };//To add 6 to the number if it is bigger than 9
19
20 assign totalSum = Z + w2 ;
21
22 endmodule |
```

\*The wave form:

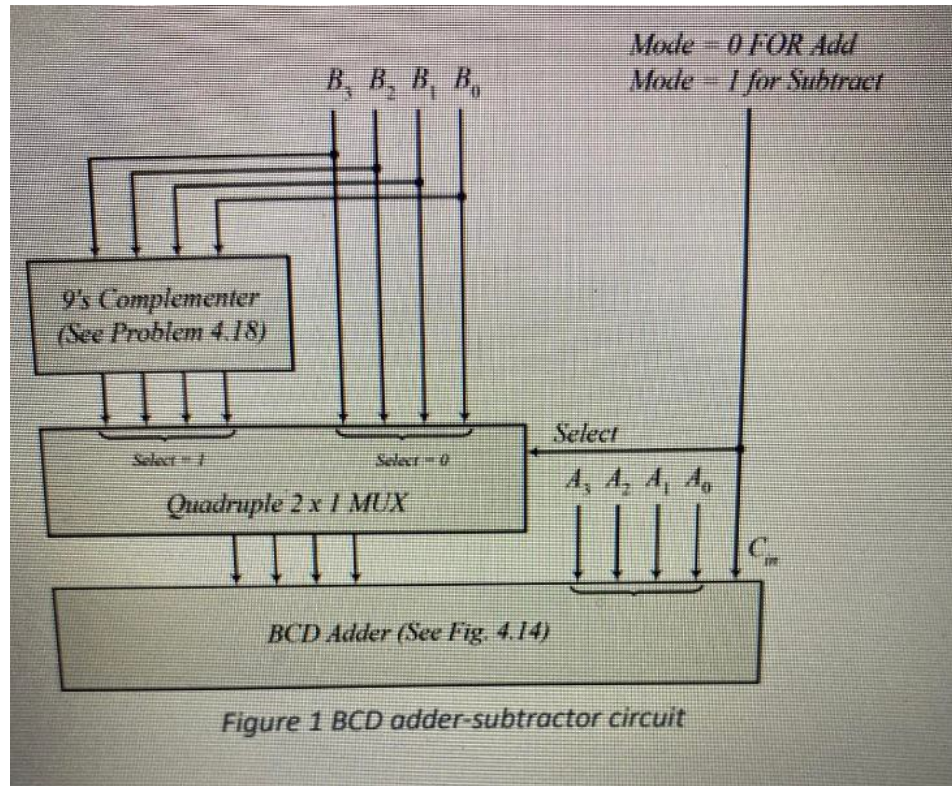




#### 4- BCD adder—subtractor circuit:

It's a combinational circuit which works as adder when the mode (selection)=0, and as a subtractor when the mode (selection)=1.

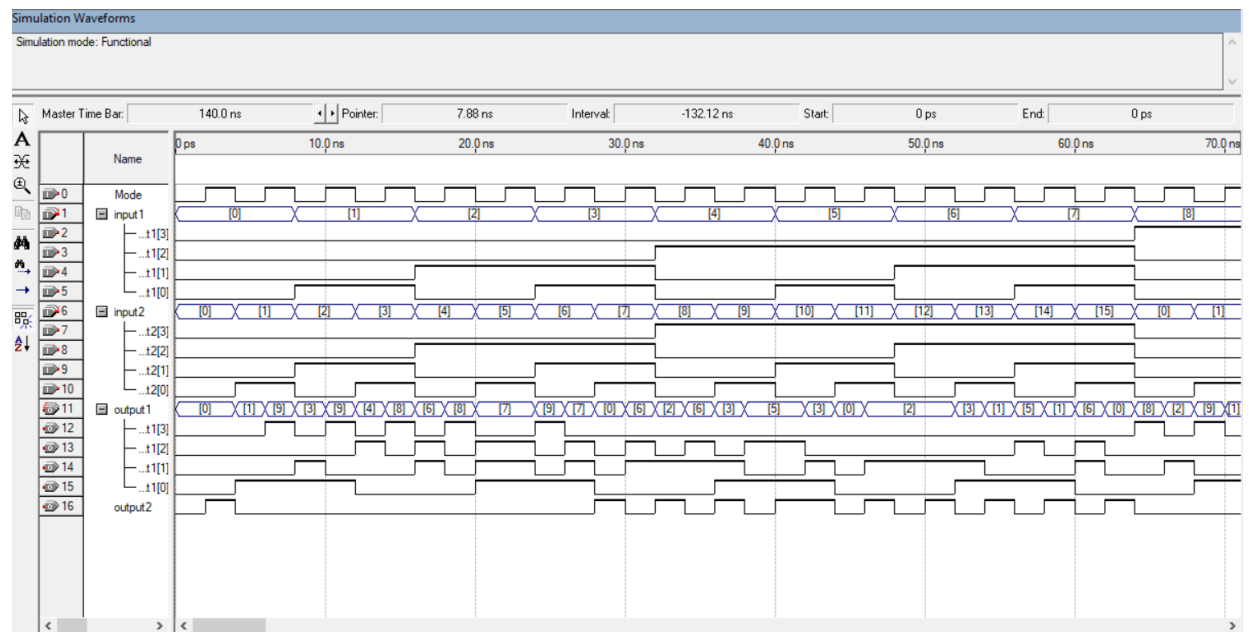
The circuit design:



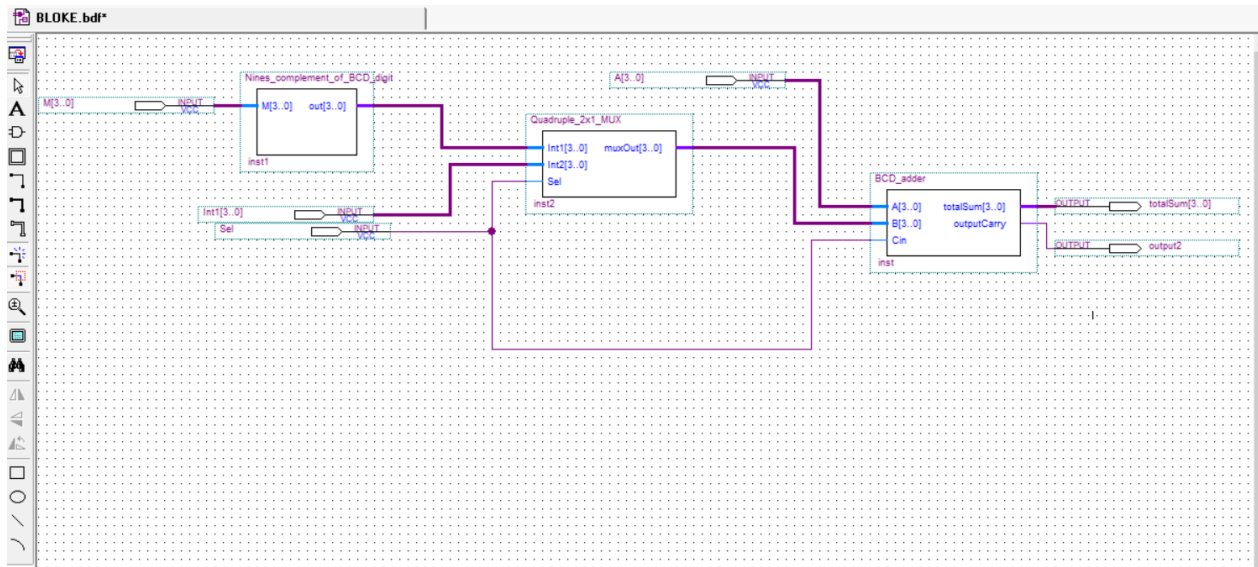
\*The module:

```
1 // The module of the BCD_adder_subtractor_circuit
2 //Author : Lana Hamayel
3 module BCD_adder_subtractor_circuit ( Mode,input1, input2, output1, output2);
4 // define the inputs and the outputs
5 input [3:0] input1,input2;
6 input Mode;
7
8 output [3:0] output1;
9 output output2 ;
10
11 wire [3:0] k1,k2;
12 // reuse the components
13 Nines_complement_of_BCD_digit g1 (input2,k1);
14 Quadruple_2x1_MUX g2 (input2,k1,k2,Mode);
15 BCD_adder g3 (input1,k2,Mode,output1,output2);
16
17 endmodule
18
19 |
```

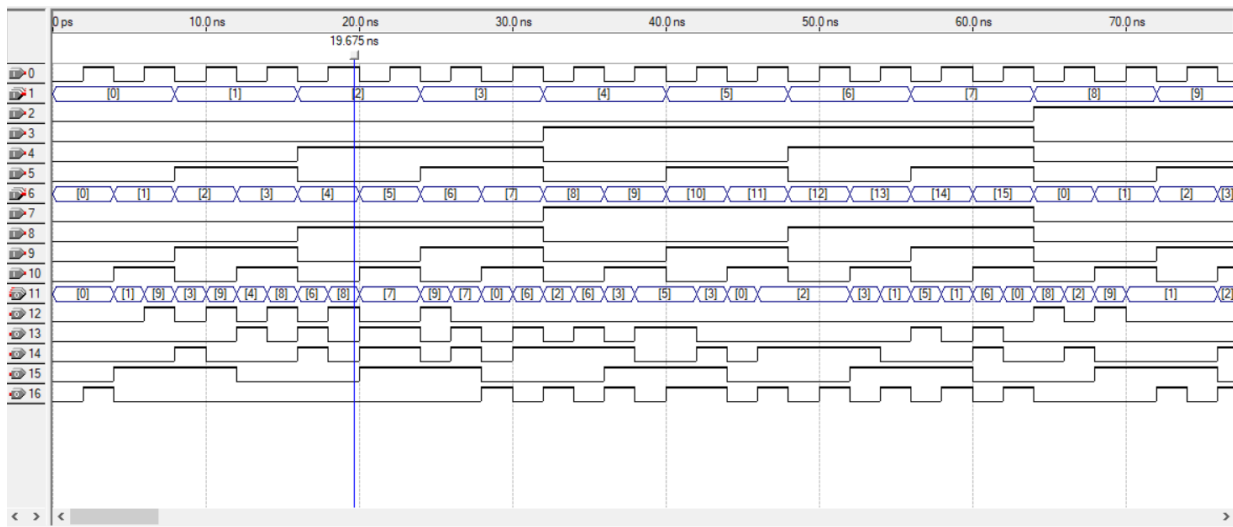
\*The wave form:



## Block Diagram:



\*The wave form:



## **Conclusion:**

To sum up the BCD adder—subtractor circuit it's works as adder when the mode = 0 and as a subtractor when the mode=1.