Task 1 : ARITHMETIC LOGIC UNIT (ALU)

Basic information:

ALU stands for Arithmetic and Logical Unit which performs Arithmetic functions like Addition, subtraction, division, etc. it also performs logical commands such as AND , OR & NOt operations .The ALU is a digital circuit inside the CPU that has the capacity to perform billions of operations per second. The ALU in the computer performs arithmetic and logical operations as part of the CPU, and as commanded by the Control Unit.ALU is a fundamental building block of a computer's central processing unit .

Output :

Operation	Inputs (A,B, opcode)	Result (Binary)	Carry Out	Zero flag
Addition	A=0100,B=1000,opcode=000	1100(12)	0	0
Substraction	A=0100,B=1000,opcode=001	1100 (12)	0 (if 8 bits carry=1)	0
AND	A=0100,B=1000,opcode=010	0000(0)	0	0
OR	A=0100,B=1000,opcode=011	1100(12)	0	0
NOT	A=0100,opcode=100	1011(11)	0	0

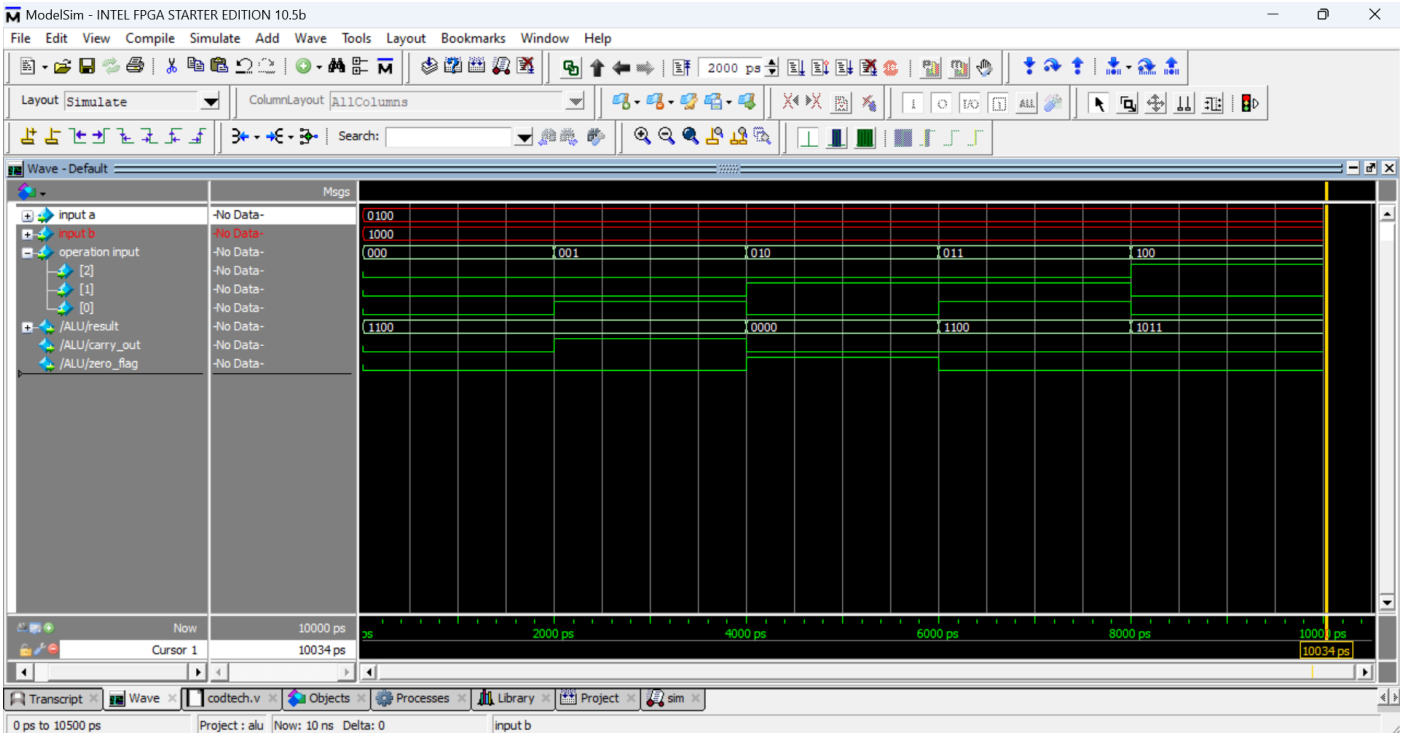
Verilog Code :

```
module ALU (
    input [3:0] A,
    input [3:0] B,
    input [2:0] opcode,
    output reg [3:0] result,
    output reg carry_out,
    output reg zero_flag
);

    always @ (A or B or opcode) begin
        case (opcode)
```

```
            3'b000: begin
                {carry_out, result} = A + B;
            end
            3'b001: begin
                {carry_out, result} = A - B;
            end
            3'b010: begin
                result = A & B;
                carry_out = 0;
            end
            3'b011: begin
                result = A | B;
                carry_out = 0;
            end
            3'b100: begin
                result = ~A;
                carry_out = 0;
            end
            default: begin
                result = 4'b0000;
                carry_out = 0;
            end
        endcase
        zero_flag = (result == 4'b0000) ? 1'b1 : 1'b0;
    end
endmodule
```

Modelsim simulation:


ModelSim - INTEL FPGA STARTER EDITION 10.5b
File Edit View Compile Simulate Add Wave Tools Layout Bookmarks Window Help
Wave - Default
Msgs
input a
input b
operation input
[2]
[1]
[0]
/ALU/result
/ALU/carry_out
/ALU/zero_flag
-No Data-
0100
1000
000
001
010
011
100
1100
0000
1100
1011
Now
10000 ps
Cursor 1
10034 ps
2000 ps
4000 ps
6000 ps
8000 ps
10000 ps
Transcript
Wave
codtech.v
Objects
Processes
Library
Project
sim
0 ps to 10500 ps
Project : alu
Now: 10 ns Delta: 0
input b