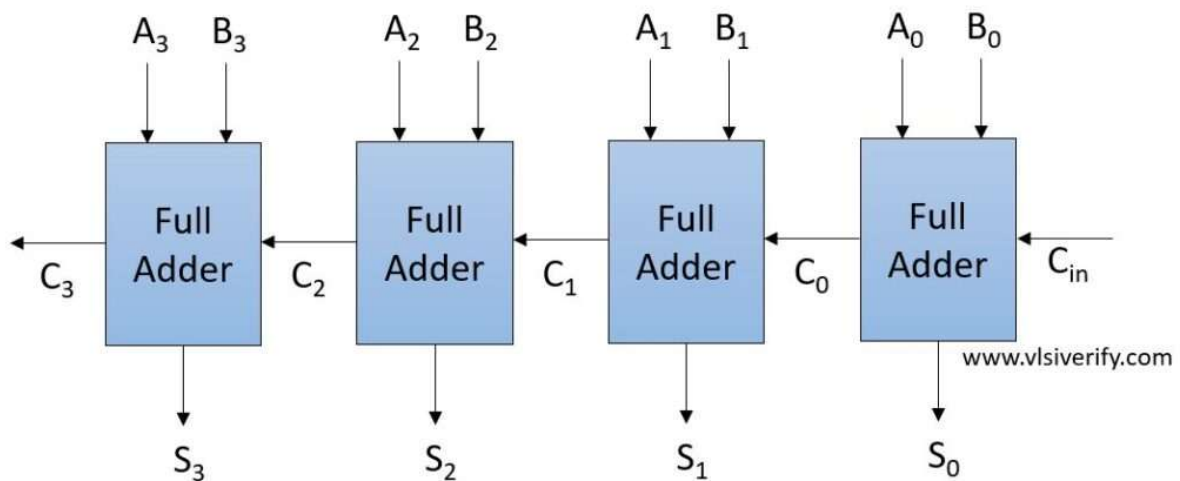# #50DAYS CHALLENGE

4 BIT RIPPLE CARRY ADDER

Block Diagram

4-Bit Ripple Carry Adder

a)Design Code

```
module full_adder(input a,b,c, output sum,carry);
 assign sum=a^b^c;
 assign carry=(a&b) | (a&c) | (b&c);
 endmodule

module ripple_carry_adder(a,b,c,sum,carry);
 input [3:0]a,b;
 input c;
 output [3:0] sum;
 output carry;
 wire c1,c2,c3;

 full_adder f1(.a(a[0]),.b(b[0]),.c(c),.sum(sum[0]),.carry(c1));
 full_adder f2(.a(a[1]),.b(b[1]),.c(c1),.sum(sum[1]),.carry(c2));
 full_adder f3(.a(a[2]),.b(b[2]),.c(c2),.sum(sum[2]),.carry(c3));
 full_adder f4(.a(a[3]),.b(b[3]),.c(c3),.sum(sum[3]),.carry(carry));

 endmodule
```
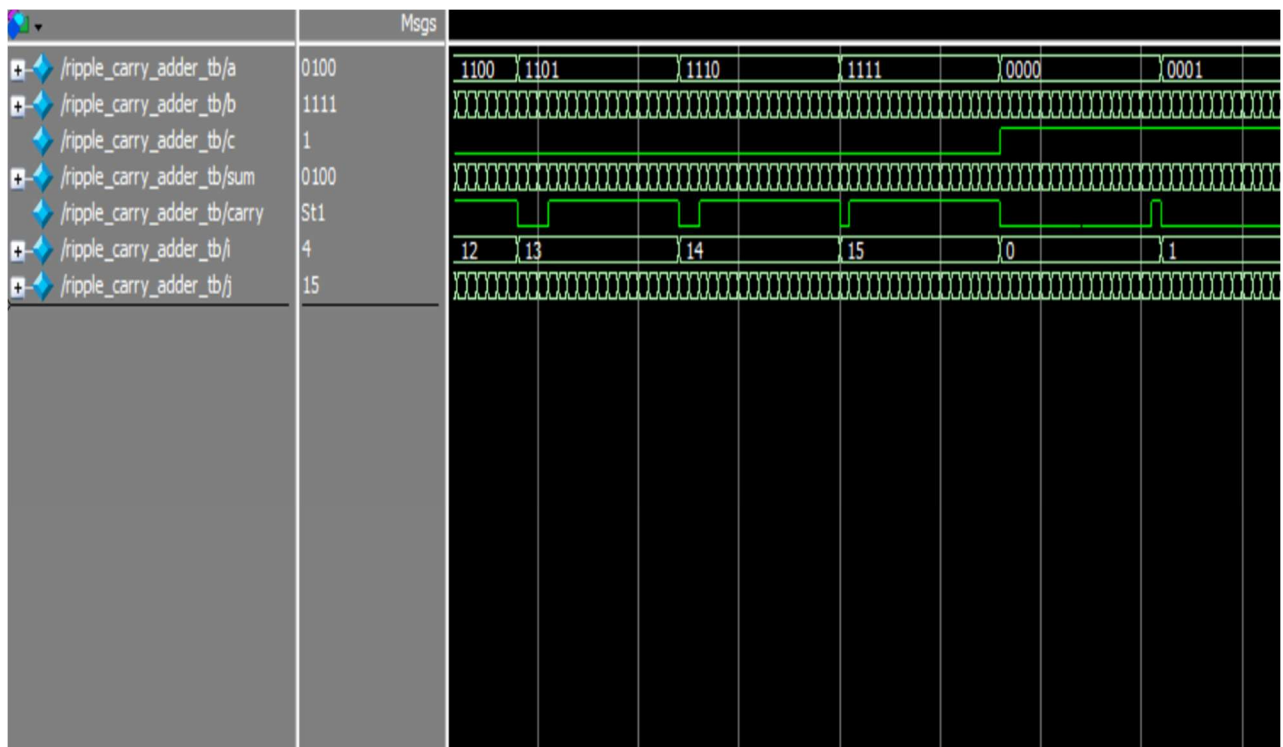
b)Testbench

```verilog
module ripple_carry_adder_tb();
 reg [3:0]a,b;
 reg c;
 wire [3:0] sum;
 wire carry;
 integer i,j;

 ripple_carry_adder dut(a,b,c,sum,carry);
 initial
begin
 c=0;
 for(i=0;i<16;i=i+1)
begin
        for(j=0;j<16;j=j+1)
begin
 a=i; b=j;
 #10;
 $display("Time=%t | a=%b |b=%b |c=%b |sum=%b |carry=%b", $time,a,b,c,sum,carry);
 end
 end
 c=1;
 for(i=0;i<16;i=i+1)
begin
        for(j=0;j<16;j=j+1)
begin
 a=i; b=j;
 #10;
 $display("Time=%t | a=%b |b=%b |c=%b |sum=%b |carry=%b", $time,a,b,c,sum,carry);
 end
 end
 $finish();
 end
 endmodule
```

c)Waveform

d)Console Output

```
# Time=                10 | a=0000 |b=0000 |c=0 |sum=0000 |carry=0
# Time=                20 | a=0000 |b=0001 |c=0 |sum=0001 |carry=0
# Time=                30 | a=0000 |b=0010 |c=0 |sum=0010 |carry=0
# Time=                40 | a=0000 |b=0011 |c=0 |sum=0011 |carry=0
# Time=                50 | a=0000 |b=0100 |c=0 |sum=0100 |carry=0
# Time=                60 | a=0000 |b=0101 |c=0 |sum=0101 |carry=0
# Time=                70 | a=0000 |b=0110 |c=0 |sum=0110 |carry=0
# Time=                80 | a=0000 |b=0111 |c=0 |sum=0111 |carry=0
# Time=                90 | a=0000 |b=1000 |c=0 |sum=1000 |carry=0
# Time=               100 | a=0000 |b=1001 |c=0 |sum=1001 |carry=0
# Time=               110 | a=0000 |b=1010 |c=0 |sum=1010 |carry=0
# Time=               120 | a=0000 |b=1011 |c=0 |sum=1011 |carry=0
# Time=               130 | a=0000 |b=1100 |c=0 |sum=1100 |carry=0
# Time=               140 | a=0000 |b=1101 |c=0 |sum=1101 |carry=0
# Time=               150 | a=0000 |b=1110 |c=0 |sum=1110 |carry=0
# Time=               160 | a=0000 |b=1111 |c=0 |sum=1111 |carry=0
# Time=               170 | a=0001 |b=0000 |c=0 |sum=0001 |carry=0
# Time=               180 | a=0001 |b=0001 |c=0 |sum=0010 |carry=0
# Time=               190 | a=0001 |b=0010 |c=0 |sum=0011 |carry=0
# Time=               200 | a=0001 |b=0011 |c=0 |sum=0100 |carry=0
# Time=               210 | a=0001 |b=0100 |c=0 |sum=0101 |carry=0
# Time=               220 | a=0001 |b=0101 |c=0 |sum=0110 |carry=0
# Time=               230 | a=0001 |b=0110 |c=0 |sum=0111 |carry=0
# Time=               240 | a=0001 |b=0111 |c=0 |sum=1000 |carry=0
# Time=               250 | a=0001 |b=1000 |c=0 |sum=1001 |carry=0
# Time=               260 | a=0001 |b=1001 |c=0 |sum=1010 |carry=0
# Time=               270 | a=0001 |b=1010 |c=0 |sum=1011 |carry=0
# Time=               280 | a=0001 |b=1011 |c=0 |sum=1100 |carry=0
# Time=               290 | a=0001 |b=1100 |c=0 |sum=1101 |carry=0
# Time=               300 | a=0001 |b=1101 |c=0 |sum=1110 |carry=0
# Time=               310 | a=0001 |b=1110 |c=0 |sum=1111 |carry=0
# Time=               320 | a=0001 |b=1111 |c=0 |sum=0000 |carry=1
# Time=               330 | a=0010 |b=0000 |c=0 |sum=0010 |carry=0
# Time=               340 | a=0010 |b=0001 |c=0 |sum=0011 |carry=0
# Time=               350 | a=0010 |b=0010 |c=0 |sum=0100 |carry=0
```