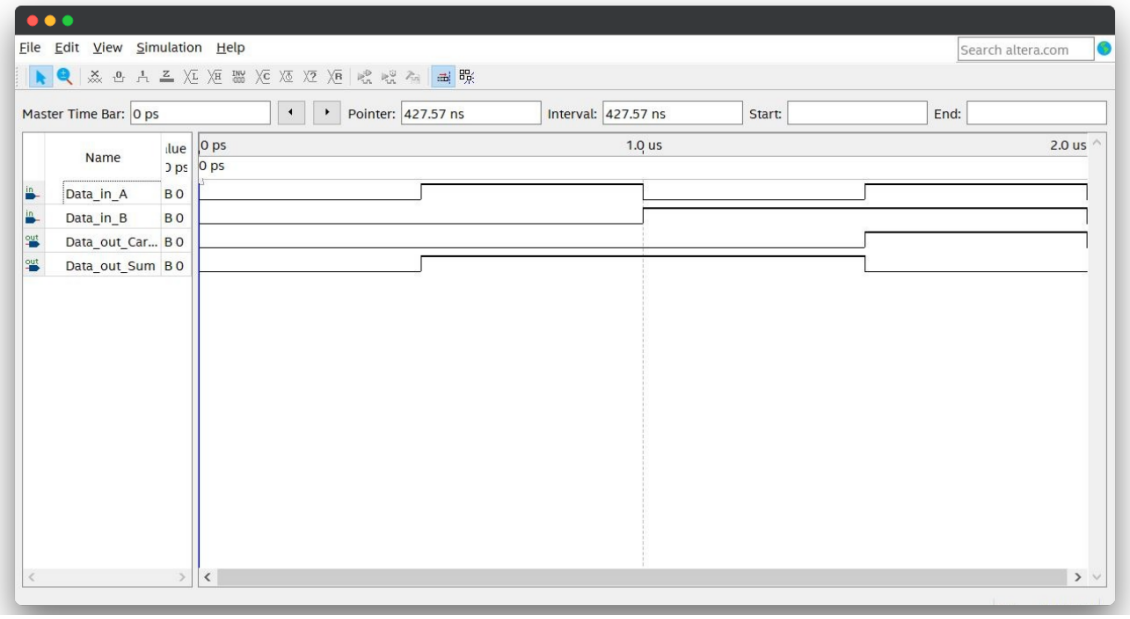
Lab Assignment 4

Question 1

Verilog Code

```verilog
module half_adder(
    output S,C,
    input A,B);

    xor(S,A,B);
    and(C,A,B);

endmodule

```

Quatrus Prime Waveform

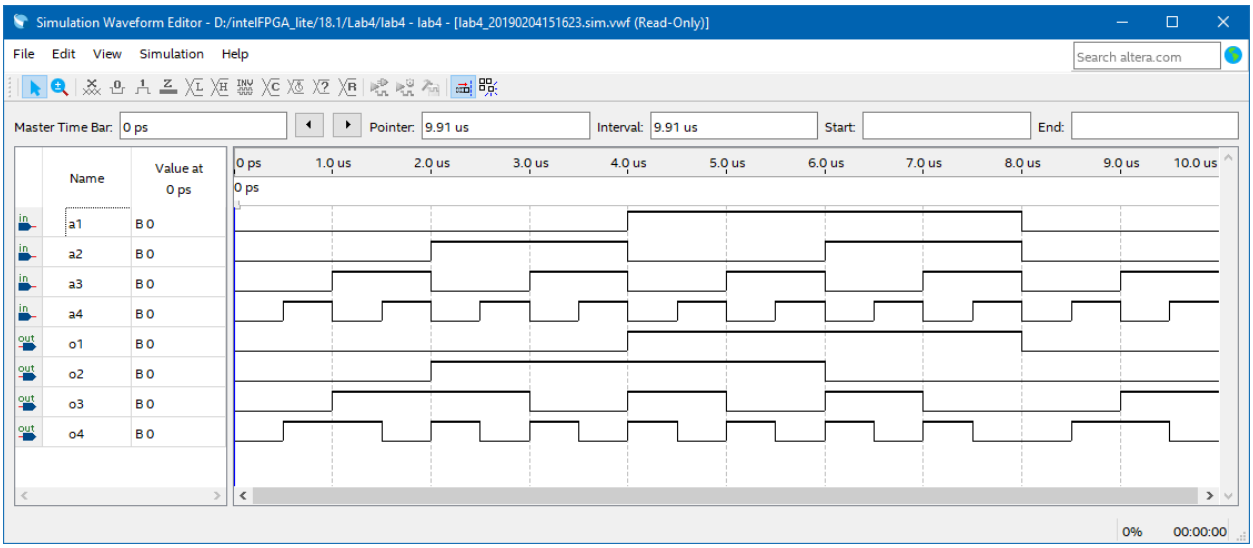


Question 2

Verilog Code

```verilog
module twos(a1, a2, a3, a4, o1, o2, o3, o4);

    input a1, a2, a3, a4;
    output o1, o2, o3, o4;
    wire c1, c2, c3, c4;
    assign c0 = 1;
    half_adder ha1(.a(~a1), .b(c0), .sum(o1), .carry(c1));
    half_adder ha2(.a(~a2), .b(c1), .sum(o2), .carry(c2));
    half_adder ha3(.a(~a3), .b(c2), .sum(o3), .carry(c3));
    half_adder ha4(.a(~a4), .b(c3), .sum(o4), .carry(c4));

endmodule

```

Quatrus Prime Waveform

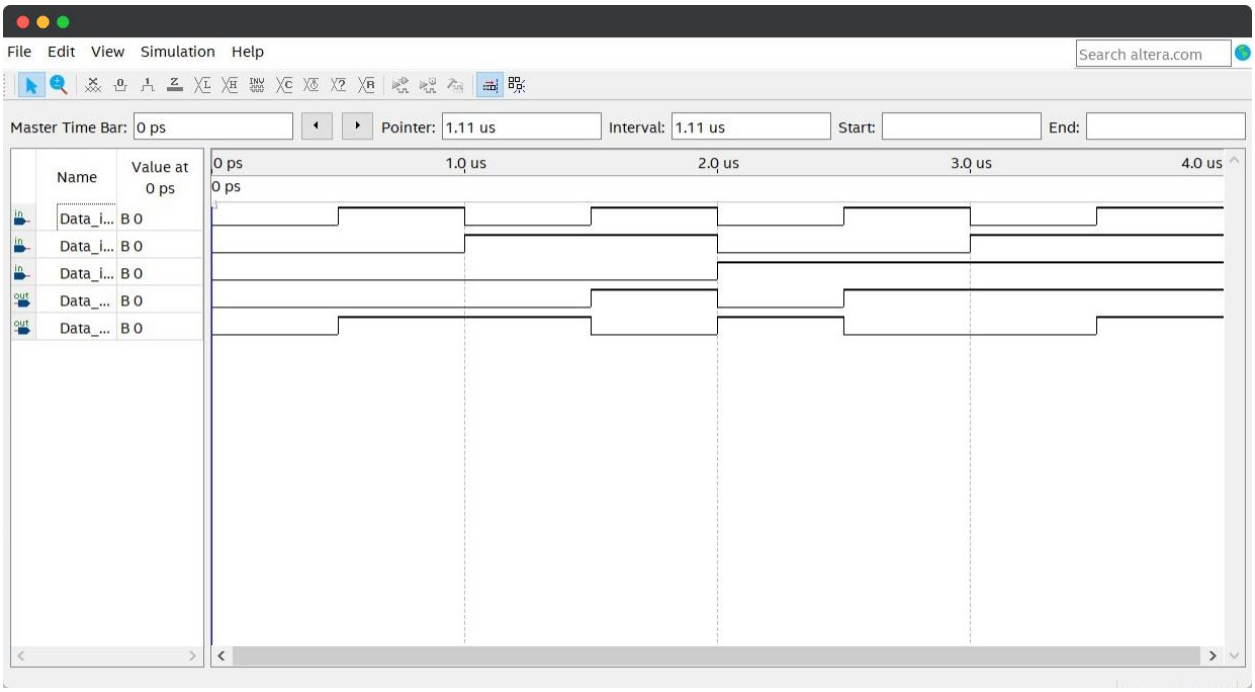


Question 3

Verilog Code

```verilog
module full_adder(
    Data_in_A,  //input A
    Data_in_B,  //input B
    Data_in_C,  //input C
    Data_out_Sum,
    Data_out_Carry
    );

    input Data_in_A;
    input Data_in_B;
     input Data_in_C;
    output Data_out_Sum;
     output Data_out_Carry;

     wire ha1_sum;
     wire ha2_sum;
     wire ha1_carry;
     wire ha2_carry;
     wire Data_out_Sum;
     wire Data_out_Carry;

    half_adder  ha1(
        .Data_in_A(Data_in_A),
        .Data_in_B(Data_in_B),
        .Data_out_Sum(ha1_sum),
        .Data_out_Carry(ha1_carry)
    );

    half_adder  ha2(
        .Data_in_A(Data_in_C),
        .Data_in_B(ha1_sum),
        .Data_out_Sum(ha2_sum),
        .Data_out_Carry(ha2_carry)
    );

    assign Data_out_Sum = ha2_sum;
    assign Data_out_Carry = ha1_carry | ha2_carry;

endmodule

```

Quatrus Prime Waveform



Question 4

Verilog Code

```
module ripple(q,w,e,r,t,y,u,i,z,x,c,v,b);
input q,w,e,r,t,y,u,i;
output z,x,c,v,b;
assign c0=0;
wire c1,c2,c3;
full_adder  ha1(
        .Data_in_A(q),
        .Data_in_B(w),
          .Data_in_C(c0),
        .Data_out_Sum(z),
        .Data_out_Carry(c1)
    );
full_adder  ha2(
        .Data_in_A(e),
        .Data_in_B(r),
          .Data_in_C(c1),
        .Data_out_Sum(x),
        .Data_out_Carry(c2)
    );
full_adder  ha3(
        .Data_in_A(t),
        .Data_in_B(y),
          .Data_in_C(c2),
        .Data_out_Sum(c),
        .Data_out_Carry(c3)
    );
full_adder  ha4(
        .Data_in_A(u),
        .Data_in_B(i),
          .Data_in_C(c3),
        .Data_out_Sum(v),
        .Data_out_Carry(b)
    );
endmodule
```

Quatrus Prime Waveform