EC Verilog Code Submission

Mohmed Husain(202351166)

Saksham Singh (202351124)

Vandit Singh (202351155)

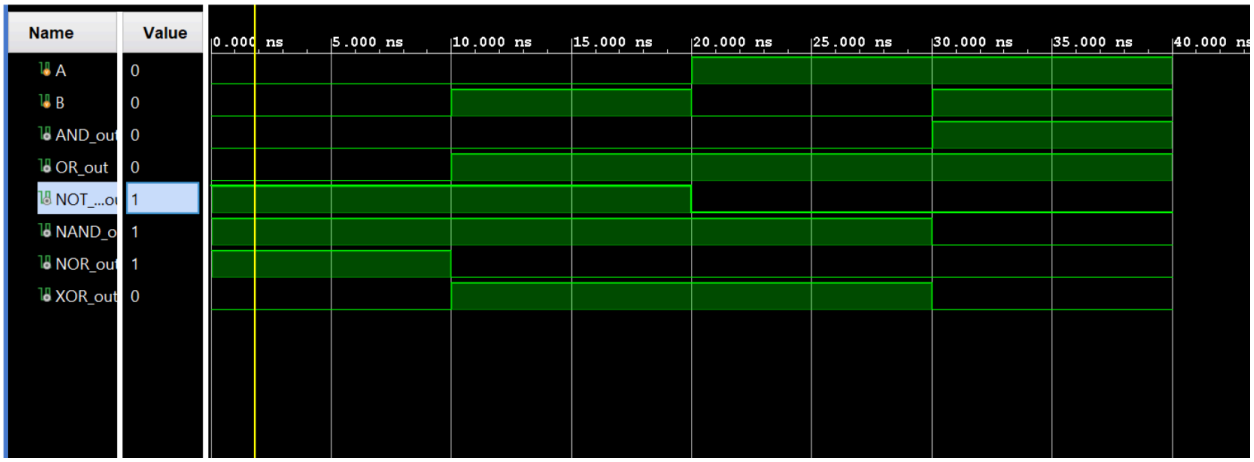
LAB 1

```
module logic_gates(
        input wire A, B,
        output wire AND_out, OR_out,
NOT_A_out, NAND_out, NOR_out,
XOR_out
);

// AND gate
and u1 (AND_out, A, B);

// OR gate


or u2 (OR_out, A, B);

// NOT gate (for input A)
not u3 (NOT_A_out, A);

// NAND gate
nand u4 (NAND_out, A, B);

// NOR gate
nor u5 (NOR_out, A, B);

// XOR gate
xor u6 (XOR_out, A, B);
```

Test bench

```
// Testbench to apply stimulus and check
outputs
module testbench;

// Testbench signals
reg A, B;
wire AND_out, OR_out, NOT_A_out,
NAND_out, NOR_out, XOR_out;

// Instantiate the logic_gates module (Unit
Under Test - UUT)
logic_gates uut (
        .A(A),
        .B(B),
        .AND_out(AND_out),
        .OR_out(OR_out),
        .NOT_A_out(NOT_A_out),
        .NAND_out(NAND_out),
        .NOR_out(NOR_out),
        .XOR_out(XOR_out)
);

// Test stimulus
initial begin
```

endmodule	// Monitor the outputs whenever A or B changes
	$monitor("A=%b, B=%b | AND_out=%b, OR_out=%b, NOT_A_out=%b, NAND_out=%b, NOR_out=%b, XOR_out=%b",
	A, B, AND_out, OR_out, NOT_A_out, NAND_out, NOR_out, XOR_out);
	
	// Apply test cases
	A = 0; B = 0; #10; // Test case 1
	A = 0; B = 1; #10; // Test case 2
	A = 1; B = 0; #10; // Test case 3
	A = 1; B = 1; #10; // Test case 4
	
	// Finish the simulation
	$finish;
	end
	
	endmodule



Lab2

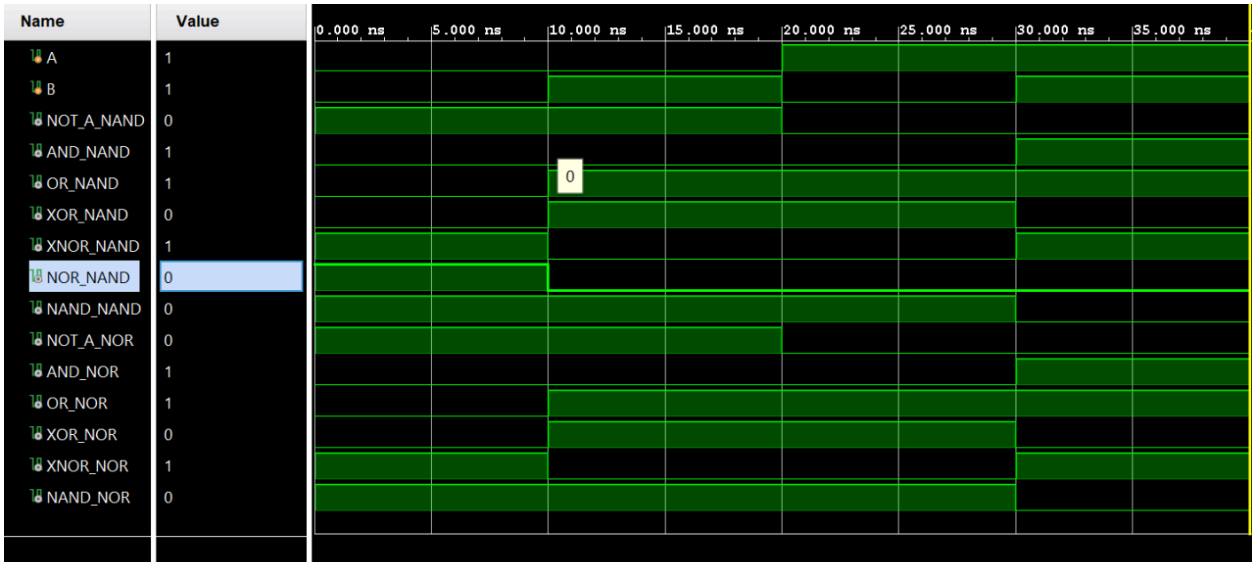
Main:	testbench:

```
// Logic Gates Using Behavioral Model
module logic_gates_behavioral(
        input wire A, B,
        output wire NOT_A_NAND,
AND_NAND, OR_NAND, XOR_NAND,
XNOR_NAND, NOR_NAND, NAND_NAND,
        output wire NOT_A_NOR, AND_NOR,
OR_NOR, XOR_NOR, XNOR_NOR,
NAND_NOR
);

        // *** Behavioral Model for Gates
Using NAND ***

        // NOT using NAND
        assign NOT_A_NAND = ~A;

        // AND using NAND
        assign AND_NAND = A & B;

        // OR using NAND
        assign OR_NAND = A | B;

        // XOR using NAND
        assign XOR_NAND = A ^ B;

        // XNOR using NAND
        assign XNOR_NAND = ~(A ^ B);

        // NOR using NAND (Behavioral
implementation of NOR using NAND gates
logic)
        assign NOR_NAND = ~(A | B);

        // NAND gate itself (already
implemented by NAND gate)
        assign NAND_NAND = ~(A & B);

        // *** Behavioral Model for Gates
Using NOR ***

        // NOT using NOR
        assign NOT_A_NOR = ~A;
```

```
// Testbench to check outputs with VCD
generation
module testbench;

        // Testbench signals
        reg A, B;
        wire NOT_A_NAND, AND_NAND,
OR_NAND, XOR_NAND, XNOR_NAND,
NOR_NAND, NAND_NAND;
        wire NOT_A_NOR, AND_NOR,
OR_NOR, XOR_NOR, XNOR_NOR,
NAND_NOR;

        // Instantiate the
logic_gates_behavioral module
        logic_gates_behavioral uut (
        .A(A), .B(B),
        .NOT_A_NAND(NOT_A_NAND),
.AND_NAND(AND_NAND),
.OR_NAND(OR_NAND),
.XOR_NAND(XOR_NAND),
.XNOR_NAND(XNOR_NAND),
.NOR_NAND(NOR_NAND),
.NAND_NAND(NAND_NAND),
        .NOT_A_NOR(NOT_A_NOR),
.AND_NOR(AND_NOR),
.OR_NOR(OR_NOR),
.XOR_NOR(XOR_NOR),
.XNOR_NOR(XNOR_NOR),
.NAND_NOR(NAND_NOR)
        );

        // Test stimulus
        initial begin
        // Create a VCD file

$dumpfile("logic_gates_behavioral_tb.vcd"); //
VCD file name
        $dumpvars(0, testbench); // Dump
variables from the testbench module

        // Monitor the outputs
```

```
        // AND using NOR (Behavioral implementation of AND using NOR gates logic)
        assign AND_NOR = A & B;

        // OR using NOR
        assign OR_NOR = A | B;

        // XOR using NOR
        assign XOR_NOR = A ^ B;

        // XNOR using NOR
        assign XNOR_NOR = ~(A ^ B);

        // NAND using NOR (Behavioral implementation of NAND using NOR gates logic)
        assign NAND_NOR = ~(A & B);

endmodule
```

```
        $monitor("A=%b, B=%b | NOT_A_NAND=%b, AND_NAND=%b, OR_NAND=%b, XOR_NAND=%b, XNOR_NAND=%b, NOR_NAND=%b, NAND_NAND=%b | NOT_A_NOR=%b, AND_NOR=%b, OR_NOR=%b, XOR_NOR=%b, XNOR_NOR=%b, NAND_NOR=%b",
                 A, B, NOT_A_NAND, AND_NAND, OR_NAND, XOR_NAND, XNOR_NAND, NOR_NAND, NAND_NAND, NOT_A_NOR, AND_NOR, OR_NOR, XOR_NOR, XNOR_NOR, NAND_NOR);

        // Apply test cases
        A = 0; B = 0; #10;
        A = 0; B = 1; #10;
        A = 1; B = 0; #10;
        A = 1; B = 1; #10;

        // Finish the simulation
        $finish;
        end

endmodule



//iverilog -o logic_gates_behavioral_tb.out logic_gates_behavioral_tb.v
//vvp logic_gates_behavioral_tb.out
//gtkwave logic_gates_behavioral_tb.vcd
```



Lab 3:

Main:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
//////////
// Company:
// Engineer:
//
// Create Date: 19.09.2024 18:07:47
// Design Name:
// Module Name: HALF_ADDER
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
```

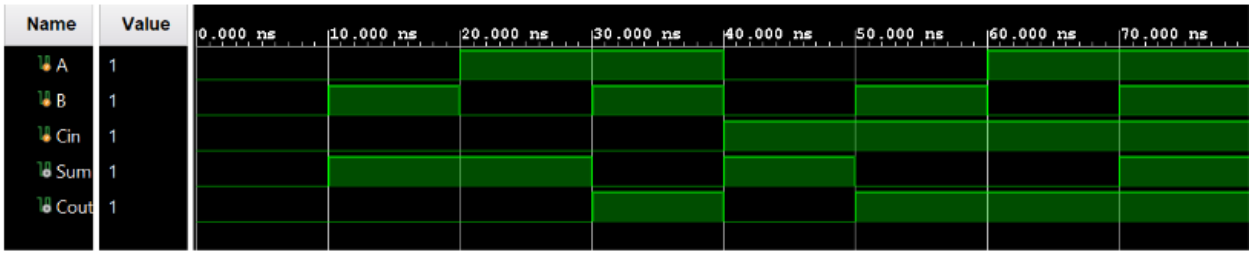
testbench:

```
// Testbench for Full Adder
module tb_full_adder;

  reg A, B, Cin;  // Test inputs
  wire Sum, Cout; // Outputs from full adder

  // Instantiate the full adder
  full_adder uut (
          .A(A),
          .B(B),
          .Cin(Cin),
          .Sum(Sum),
          .Cout(Cout)
  );

  initial begin
          // Create a VCD file for GTKWave
          $dumpfile("full_adder_tb.vcd");
          $dumpvars(0, tb_full_adder);

          // Display the outputs
          $monitor("A=%b B=%b Cin=%b |
Sum=%b Cout=%b", A, B, Cin, Sum, Cout);
```

```
////////////////////////////////////////////////////////////////////////////////
//////////
module HALF_ADDER(
        input A,
        input B,
        output SUM,
        output CARRY
        );
        xor(SUM,A,B);
        and(CARRY,A,B);
endmodule
testbench:
// Testbench for Half Adder with VCD for
GTKWave
module testbench;

        // Testbench signals
        reg A, B;        // Inputs to the half
adder
        wire SUM, CARRY;    // Outputs from
the half adder

        // Instantiate the half_adder module
        half_adder uut (
        .A(A),
        .B(B),
        .SUM(SUM),
        .CARRY(CARRY)
        );

        // Test stimulus
        initial begin
        // Open a VCD file for GTKWave
        $dumpfile("half_adder.vcd");   //
Specify the name of the VCD file
        $dumpvars(0, testbench);      // Dump
all variables for the module 'testbench'

        // Monitor the inputs and outputs
        $monitor("A=%b, B=%b | SUM=%b,
CARRY=%b", A, B, SUM, CARRY);

        // Apply test cases
        // Test cases
        A = 0; B = 0; Cin = 0; #10;
        A = 0; B = 1; Cin = 0; #10;
        A = 1; B = 0; Cin = 0; #10;
        A = 1; B = 1; Cin = 0; #10;
        A = 0; B = 0; Cin = 1; #10;
        A = 0; B = 1; Cin = 1; #10;
        A = 1; B = 0; Cin = 1; #10;
        A = 1; B = 1; Cin = 1; #10;

        // End the simulation
        $finish;
end
```

```
        A = 0; B = 0; #10;  // Test case 1: 0 + 0
        A = 0; B = 1; #10;  // Test case 2: 0 + 1
        A = 1; B = 0; #10;  // Test case 3: 1 + 0
        A = 1; B = 1; #10;  // Test case 4: 1 + 1

        // Finish the simulation
        $finish;
        end

endmodule


//iverilog -o half_adder_tb.out half_adder_tb.v
half_adder.v
//vvp half_adder_tb.out
//gtkwave half_adder.vcd
Main_fulladder:
// Full Adder module
module full_adder(
        input wire A,    // First input
        input wire B,    // Second input
        input wire Cin,  // Carry-in input
        output wire Sum,  // Sum output
        output wire Cout  // Carry-out output
);

// Intermediate values for half-adders
wire Sum1, Carry1, Carry2;

// First half adder (A and B)
assign Sum1 = A ^ B;            // First sum
assign Carry1 = A & B;   // First carry

// Second half adder (Sum1 and Cin)
assign Sum = Sum1 ^ Cin;  // Final sum
assign Carry2 = Sum1 & Cin;  // Second carry

// Final carry out
assign Cout = Carry1 | Carry2;

endmodule
```

Full adder:



Lab 4

Main:
Demux:

```
`timescale 1ns / 1ps
//// File: demux_1to8.v
module demux_1to8 (
        input wire i,               // Input
        input wire [2:0] sel,   // 3-bit selection
line
        output reg y0,              // Output 0
        output reg y1,
        output reg y2,
        output reg y3,
        output reg y4,
        output reg y5,
        output reg y6,
        output reg y7
);
        always @(*) begin
        y0 = 0;
        y1 = 0;
        y2 = 0;
        y3 = 0;
        y4 = 0;
        y5 = 0;
        y6 = 0;
        y7 = 0;
```

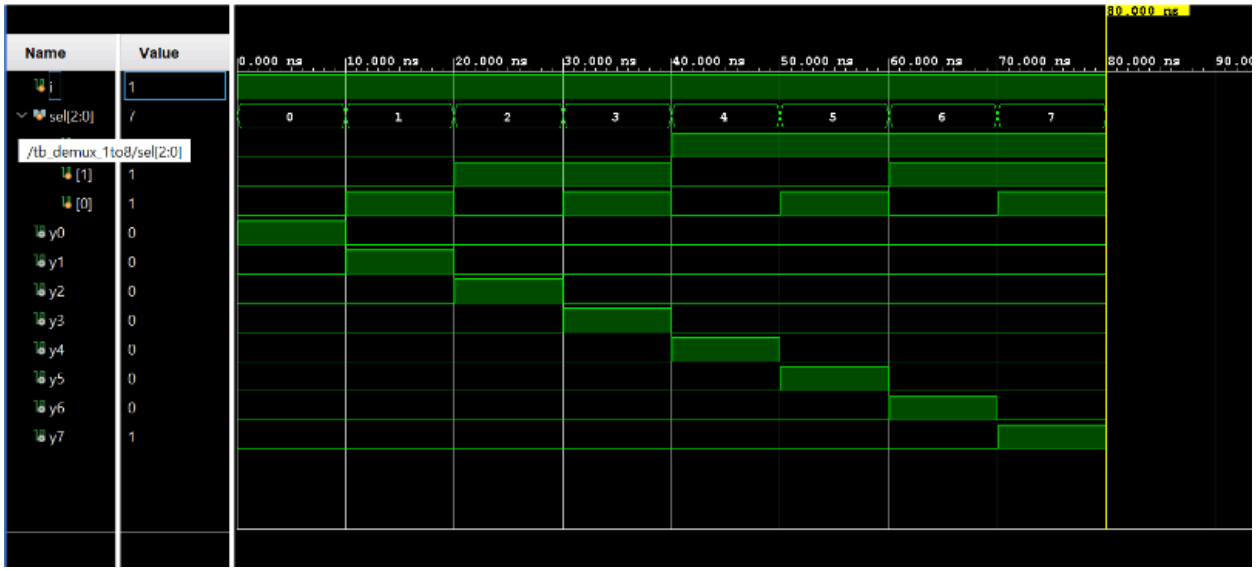
testbench:demux:

```
`timescale 1ns / 1ps
//// File: tb_demux_1to8.v
module tb_demux_1to8;
        reg i;
        reg [2:0] sel;
        wire y0, y1, y2, y3, y4, y5, y6, y7;

        // Instantiate the DEMUX
        demux_1to8 uut (
        .i(i),
        .sel(sel),
        .y0(y0), .y1(y1), .y2(y2), .y3(y3),
        .y4(y4), .y5(y5), .y6(y6), .y7(y7)
        );

        initial begin
        // Initialize input
        i = 1;
        sel = 3'b000; #10;
        sel = 3'b001; #10;
        sel = 3'b010; #10;
        sel = 3'b011; #10;
        sel = 3'b100; #10;
        sel = 3'b101; #10;
        sel = 3'b110; #10;
        sel = 3'b111; #10;
        $finish;
        end
```

```
        case(sel)
        3'b000: y0 = i;
        3'b001: y1 = i;
        3'b010: y2 = i;
        3'b011: y3 = i;
        3'b100: y4 = i;
        3'b101: y5 = i;
        3'b110: y6 = i;
        3'b111: y7 = i;
        default: ;
        endcase
        end
endmodule
```

```
initial begin
        $monitor("sel=%b, y0=%b, y1=%b,
y2=%b, y3=%b, y4=%b, y5=%b, y6=%b,
y7=%b", sel, y0, y1, y2, y3, y4, y5, y6, y7);
        end
endmodule
```

Demux:



Main:mux:

```
`timescale 1ns / 1ps
// File: mux_8to1.v
module mux_8to1 (
        input wire [2:0] sel,  // 3-bit selection
line
        input wire i0,              // Input 0
```

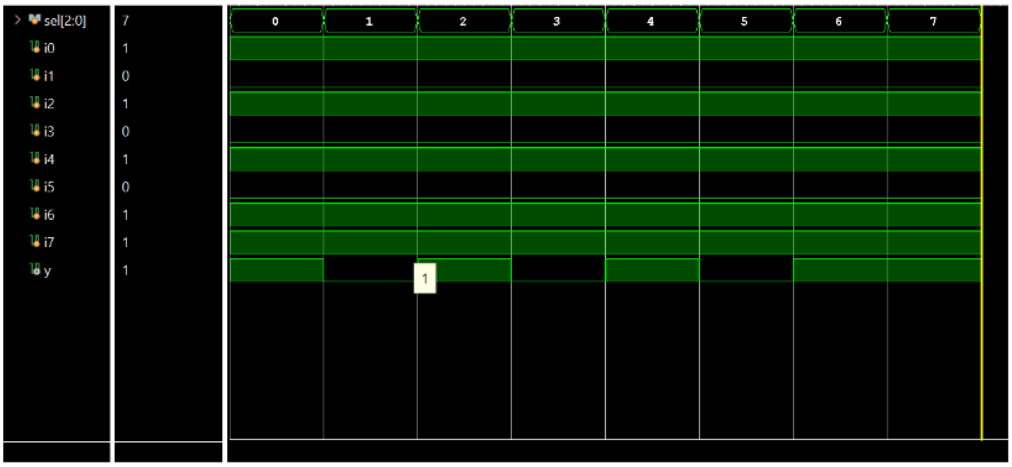
Testbench:mux:

```
`timescale 1ns / 1ps
/// File: tb_mux_8to1.v
module tb_mux_8to1;
        reg [2:0] sel;
        reg i0, i1, i2, i3, i4, i5, i6, i7;
        wire y;
```

```
        input wire i1,          // Input 1
        input wire i2,          // Input 2
        input wire i3,          // Input 3
        input wire i4,          // Input 4
        input wire i5,          // Input 5
        input wire i6,          // Input 6
        input wire i7,          // Input 7
        output reg y            // Output
);
        always @(*) begin
        case(sel)
        3'b000: y = i0;
        3'b001: y = i1;
        3'b010: y = i2;
        3'b011: y = i3;
        3'b100: y = i4;
        3'b101: y = i5;
        3'b110: y = i6;
        3'b111: y = i7;
        default: y = 1'bx;
        endcase
        end
endmodule
```

```
        // Instantiate the MUX
        mux_8to1 uut (
        .sel(sel),
        .i0(i0), .i1(i1), .i2(i2), .i3(i3),
        .i4(i4), .i5(i5), .i6(i6), .i7(i7),
        .y(y)
        );

        initial begin
        // Initialize inputs
        {i0, i1, i2, i3, i4, i5, i6, i7} =
8'b10101011;
        sel = 3'b000; #10;
        sel = 3'b001; #10;
        sel = 3'b010; #10;
        sel = 3'b011; #10;
        sel = 3'b100; #10;
        sel = 3'b101; #10;
        sel = 3'b110; #10;
        sel = 3'b111; #10;
        $finish;
        end

        initial begin
        $monitor("sel=%b, y=%b", sel, y);
        end
endmodule
```

MUX:



LAB 5:

Main:

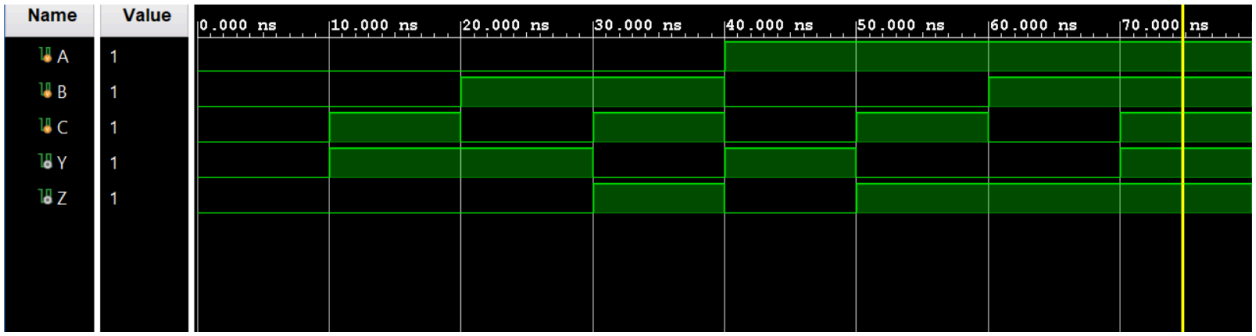
```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 26.09.2024 15:18:17
// Design Name:
// Module Name: LAB5_NAND
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module LAB5_NAND(
        input A,
        input B,
        input C,
        output Y,
        output Z
        );
        wire a1,a2,a3,a4,a5,a6,a7,a8,a9;
        assign a1=~(A&B);   // nand one

        assign a2 =~(B&a1); //nand 2

        assign a3=~(A&a1) ;//nand 3
```

testbench:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Testbench for LAB5_NAND
//////////////////////////////////////////////////////////////////////////////////

module LAB5_NAND_tb();

        // Inputs
        reg A;
        reg B;
        reg C;

        // Outputs
        wire Y,Z;


        // Instantiate the Unit Under Test
(UUT)
        LAB5_NAND uut(A,B,C,Y,Z);



        initial begin

        A = 0; B = 0; C = 0;// Test case 1
        #10;


        A = 0; B = 0; C = 1; // Test case 2
        #10;


        A = 0; B = 1; C = 0;     // Test case 3
        #10;
```

```
        assign a4 = ~(a2&a3); //nand 4

        assign a5 =~(a4&C); // nand 5

        assign a6=~(a4&a5) ;//nand 6

        assign a7=~(a5&a1);// nand 7 ->
output ->Z

        assign a8=~(C&a5);// nand 8;

        assign a9=~(a6&a8);  // nand 9
->output->Y

        //assigning value to outputs
        assign Z=a7;

        assign Y=a9;


endmodule
```

```
        A = 0; B = 1; C = 1;  // Test case 4
        #10;


        A = 1; B = 0; C = 0; // Test case 5
        #10;


        A = 1; B = 0; C = 1; // Test case 6
        #10;


        A = 1; B = 1; C = 0;  // Test case 7
        #10;

        A = 1; B = 1; C = 1;// Test case 8
        #10;

        // Finish simulation
        $finish;
        end

endmodule
```



LAB_6

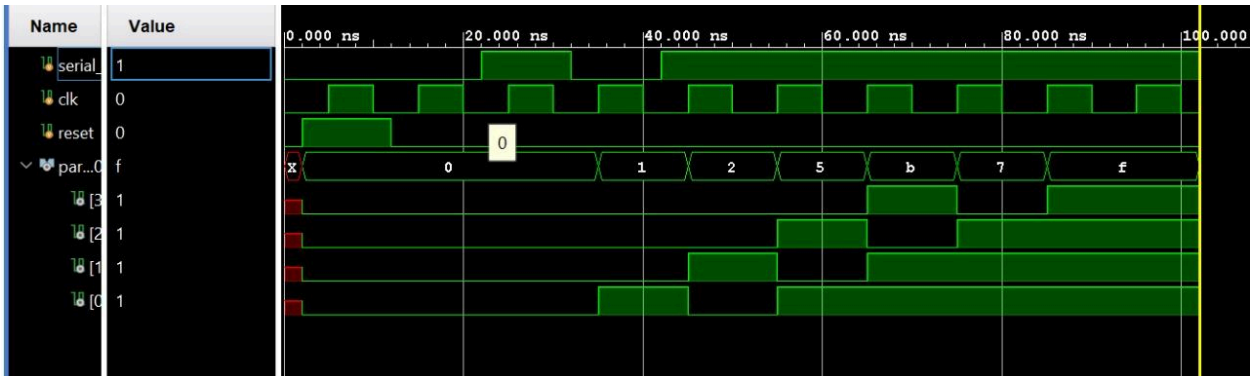
Main: Siso: // SISO (Serial In Serial Out) Shift Register module SISO (	Testbench: Siso: `timescale 1ns / 1ps

```
        input wire serial_in,    // Serial input
        input wire clk,          // Clock input
        input wire reset,        // Asynchronous
reset
        output reg serial_out  // Serial output
);
        reg [3:0] shift_reg;     // 4-bit shift
register

        always @(posedge clk or posedge
reset) begin
        if (reset) begin
        shift_reg <= 4'b0000; // Reset shift
register to 0
        serial_out <= 0;         // Reset output
to 0
        end else begin
        shift_reg <= {shift_reg[2:0], serial_in};
// Shift left and input new bit
        serial_out <= shift_reg[3]; // Output
the last bit
        end
        end
endmodule
```

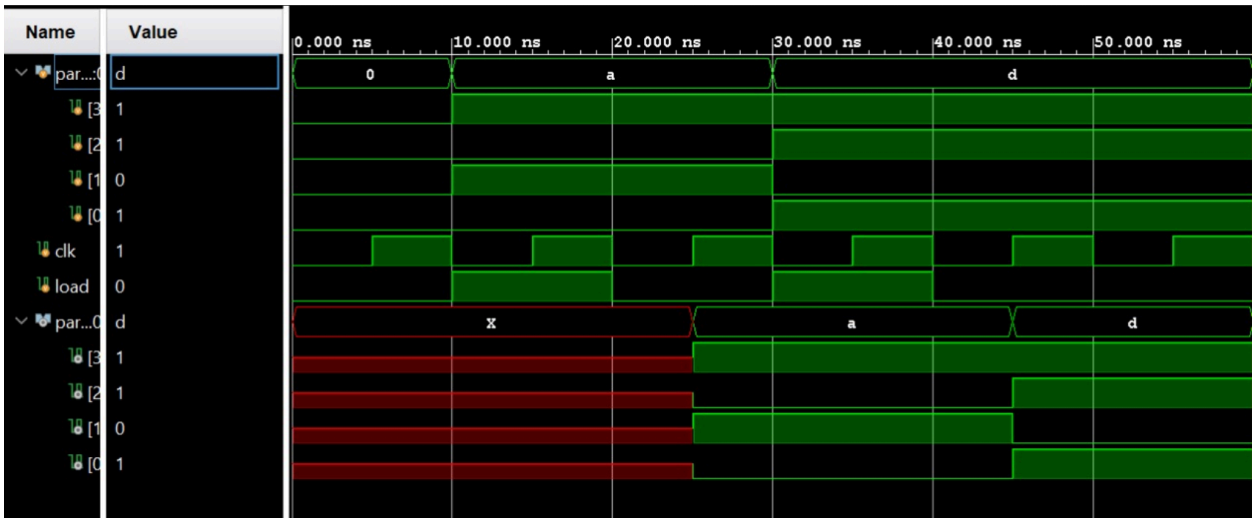
```
module SISO_tb;
        // Inputs
        reg serial_in;
        reg clk;
        reg reset;

        // Output
        wire serial_out;

        // Instantiate the Unit Under Test
(UUT)
        SISO uut (
        .serial_in(serial_in),
        .clk(clk),
        .reset(reset),
        .serial_out(serial_out)
        );

        // Clock generation
        initial begin
        clk = 0;
        forever #5 clk = ~clk; // Generate a
clock with 10ns period
        end

        // Test stimulus
        initial begin
        // Initialize inputs
        serial_in = 0;
        reset = 0;

        // Apply reset
        #2 reset = 1;  // Assert reset
        #10 reset = 0; // Deassert reset

        // Test case: Shift in a series of bits
        #10 serial_in = 1; // Shift in 1
        #10 serial_in = 0; // Shift in 0
        #10 serial_in = 1; // Shift in 1
        #10 serial_in = 1; // Shift in 1

        // Wait and observe
        #40 $finish;
```

```
        end

        // Monitor changes
        initial begin
        $monitor("Time=%0t | reset=%b |
serial_in=%b | shift_reg=%b | serial_out=%b",
                 $time, reset, serial_in,
uut.shift_reg, serial_out);
        end
endmodule
```

Siso



PIPO



LAB 7:

Main:ring counter

```
module RingCounter(
        input clk,
        input reset,
        output reg [3:0] q
);
        always @(posedge clk or posedge
reset) begin
        if (reset)
        q <= 4'b0001; // Reset to initial state
        else
        q <= {q[2:0], q[3]}; // Shift left and
wrap around
        end
endmodule
```

testbench:ring counter

```
`timescale 1ns / 1ps

module ring_counter_tb;
        reg clk;
        reg reset;
        wire [3:0] q;

        // Instantiate the RingCounter module
        ring_counter uut (
        .clk(clk),
        .reset(reset),
        .q(q)
        );

        // Clock generation
        initial begin
        clk = 0;
        forever #5 clk = ~clk; // Generate a
clock with a period of 10 ns
        end

        // Test sequence
```

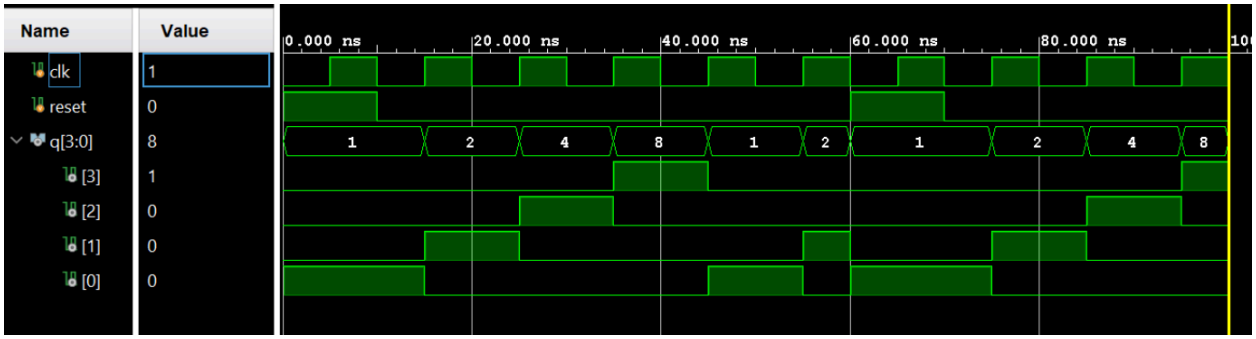
testbench:

```
module tb_SyncCounter;
        reg clk;
        reg reset;
        wire [1:0] q;
        // Instantiate the SyncCounter module
        SyncCounter uut (
        .clk(clk),
        .reset(reset),
        .q(q)
        );
        // Clock generation
        initial begin
        clk = 0;
        forever #5 clk = ~clk; // 10 time units
period
        end
        // Test sequence
        initial begin
        $monitor($time, " Reset=%b, Q=%b",
reset, q);
        reset = 1; #10; // Apply reset
        reset = 0; #50; // Run for a few cycles
        reset = 1; #10; // Apply reset again
        reset = 0; #30; // Run for a few more
cycles
        $stop;
        end
endmodule
```

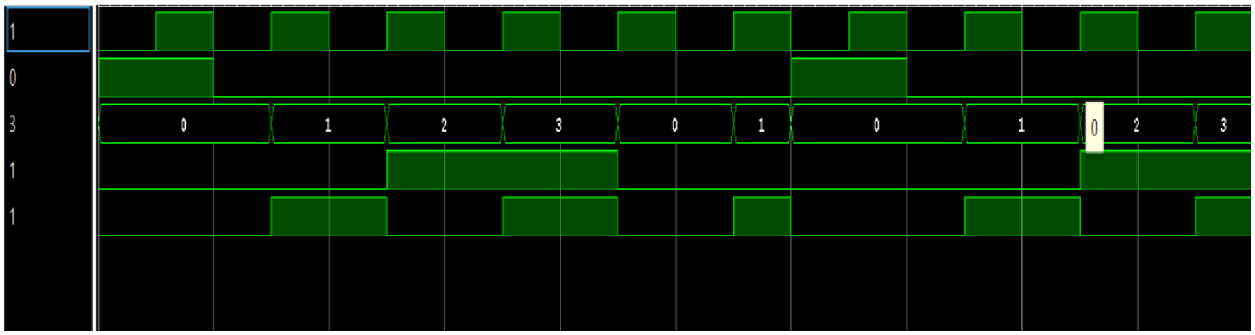
```
        initial begin
        // Initialize simulation
        $display("Starting simulation...");

        // Apply reset
        reset = 1;
        #10; // Hold reset high for 10 ns
        $display("Time: %0t, Reset applied,
Q: %b", $time, q);

        // Release reset and observe ring
counter
        reset = 0;
        #50; // Run simulation for 50 ns
        $display("Time: %0t, Reset released,
Q after 50 ns: %b", $time, q);

        // Apply reset again to verify reset
functionality
        reset = 1;
        #10;
        $display("Time: %0t, Reset applied
again, Q: %b", $time, q);

        reset = 0;
        #30;
        $display("Time: %0t, Final Q after
additional 30 ns: %b", $time, q);

        // End simulation
        $display("Ending simulation...");
        $stop;
        end
endmodule
main:
sync:counter
module sync_counter(
        input clk,
        input reset,
        output reg [1:0] q
);
        always @(posedge clk or posedge
reset) begin
```

```
        if (reset)
        q <= 2'b00; // Reset to 0
        else
        q <= q + 1; // Increment counter
        end
endmodule
```

Ring counter



Sync counter



LAB 8:

Main:	Test bench:

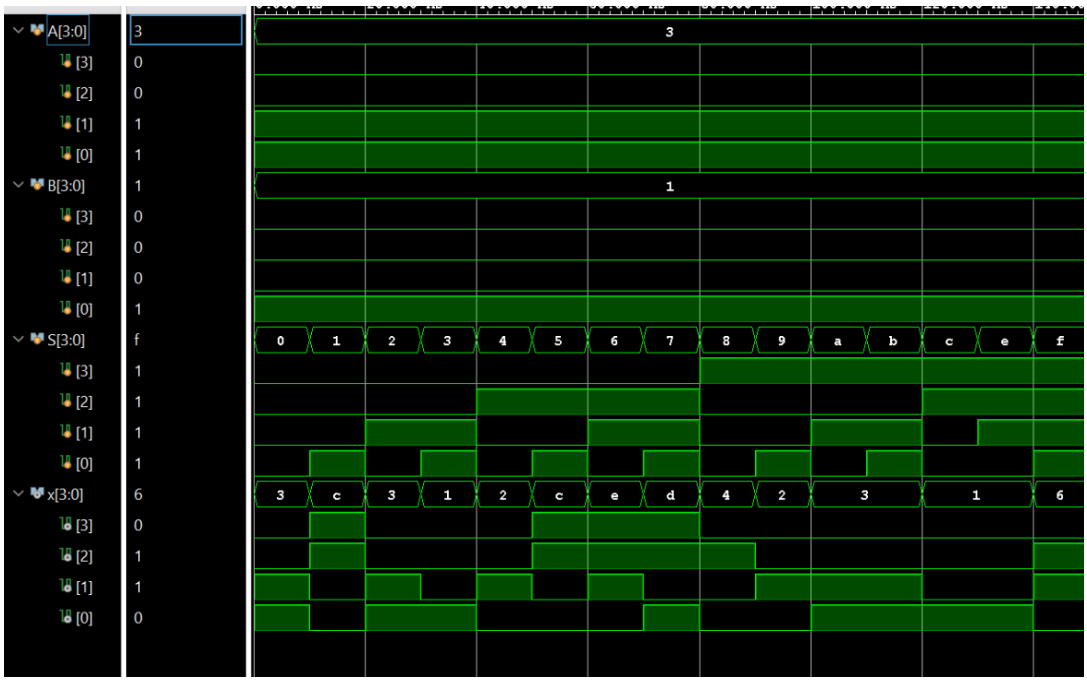
`timescale 1ns / 1ps
//
// Company:
// Engineer:
//
// Create Date: 07.11.2024 15:58:05
// Design Name: ALU
	`timescale 1ns / 1ps
	//
	// Company:
	// Engineer:
	//
	// Create Date: 07.11.2024
	// Design Name: ALU Testbench

```
// Module Name: ALU
// Project Name:
// Target Devices:
// Tool Versions:
// Description: 4-bit ALU with 16 operations
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////

module ALU(
        input wire [3:0] A,
        input wire [3:0] B,
        input wire [3:0] S,
        output reg [3:0] x
);

        always @(*) begin

        case (S)
        4'b0000: x = A;

        4'b0001: x = ~A;

        4'b0010: x = A | B;

        4'b0011: x = A & B;

        4'b0100: x = A ^ B;

        4'b0101: x = ~(A | B);

        4'b0110: x = ~(A & B);

        4'b0111: x = ~(A ^ B);

        4'b1000: x = A + B;
```

```
// Module Name: ALU_tb
// Project Name:
// Target Devices:
// Tool Versions:
// Description: Testbench for 4-bit ALU with 16 operations
//
//////////////////////////////////////////////////////////////////////////////////

module ALU_tb;
        // Testbench registers and wires
        reg [3:0] A;
        reg [3:0] B;
        reg [3:0] S;
        wire [3:0] x;


        ALU uut (
        .A(A),
        .B(B),
        .S(S),
        .x(x)
        );


        initial begin


        A = 4'b0011; B = 4'b0001;


        S = 4'b0000; #10;
        S = 4'b0001; #10;
        S = 4'b0010; #10;
        S = 4'b0011; #10;
        S = 4'b0100; #10;
        S = 4'b0101; #10;
        S = 4'b0110; #10;
        S = 4'b0111; #10;
        S = 4'b1000; #10;
        S = 4'b1001; #10;
        S = 4'b1010; #10;
```

```
        4'b1001: x = A - B;

        4'b1010: x = A * B;

        4'b1011: x = (B != 0) ? (A / B) :
4'b0000;

        4'b1100: x = (A > B) ? 4'b0001 :
4'b0000;

        4'b1101: x = A ** B;

        4'b1110: x = A >> B;

        4'b1111: x = A << B;

        default: x = 4'b0000;
        endcase
        end

endmodule
```

```
        S = 4'b1011; #10;
        S = 4'b1100; #10;
        S = 4'b1110; #10;
        S = 4'b1111; #10;


        $finish;
        end
endmodule
```



Lab 9:

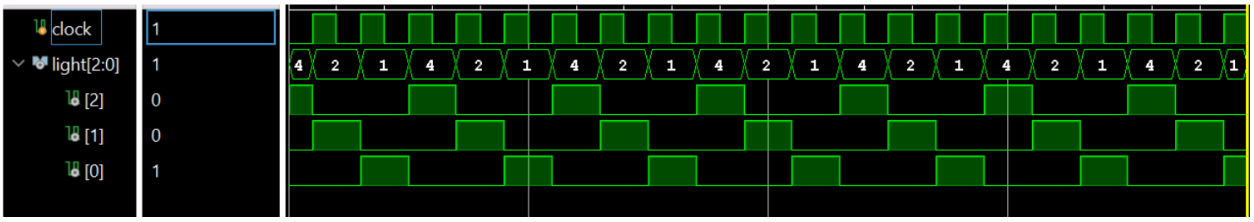
Main:

```
module cyclic_lamp(clock, light);
	input clock;
	output reg [2:0] light; //light is a vector
	parameter s0=2'b00, s1=2'b01,
s2=2'b10; // parameter declaration as
constant \
	parameter RED=3'b100,
GREEN=3'b010, YELLOW=3'b001;
	reg[1:0] state=s0; //state as two bit
variable
	reg[27:0] count=0;
	reg clock_out;

//	always@( posedge clock )
//	begin
//	count<=count+1;
//	if (count==100000000)
//	begin count<=0;
//		clock_out=~clock_out;
//	end
//	end

	initial begin
	state = s0;
	light = RED;
	clock_out = 0;
	end

	always@(posedge clock )
	case (state)
	s0: state<=s1;
	s1: state<=s2;
	s2: state<=s0;
	default: state<=s0;
	endcase

	always@(state)
	case(state)
```

Testbench:

```
`timescale 1ns / 1ps

module tb_cyclic_lamp;

// Inputs
reg clock;

// Outputs
wire [2:0] light;

// Instantiate the Unit Under Test (UUT)
cyclic_lamp uut (
	.clock(clock),
	.light(light)
);

// Clock generation
initial begin
	clock = 0;
	forever #5 clock = ~clock; // Generate
a clock signal with a period of 10 ns
end

// Testbench process
initial begin
	// Display header
	$display("Time\tClock\tLight");

	// Monitor the changes in outputs
	$monitor("%4d\t%b\t%b", $time, clock,
light);

	// Simulation run for 100 clock cycles
	#1000;
	$finish;
end

endmodule
```

```
        s0: light=RED;
        s1: light=GREEN;
        s2: light=YELLOW;
        default light=RED;
        endcase
endmodule
```



LAB 10:

Main:
Ocla:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 21.11.2024 15:43:15
// Design Name:
// Module Name: OCLA
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
```

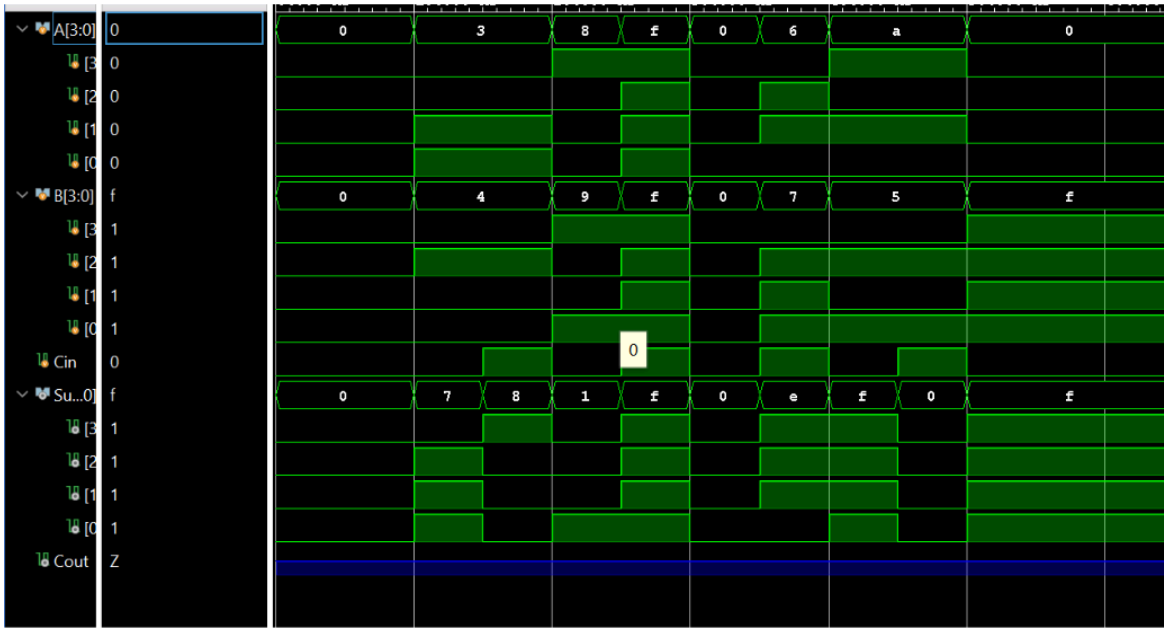
Testbench;

```
`timescale 1ns/1ps

module OCLA_tb;
        // Testbench signals
        reg [3:0] A, B;
        reg Cin;
        wire [3:0] Sum;
        wire Cout;

        // Instantiate the CLA module
        OCLA cla_inst (
        .A(A),
        .B(B),
        .Cin(Cin),
        .Sum(Sum),
        .Cout(Cout)
        );

        // Helper task to display test results
        task display_test;
```

```
//
//////////////////////////////////////////////////////////////////////////////////
/////////

module OCLA (
        input [3:0] A,
        input [3:0] B,
        input Cin,
        output [3:0] Sum,
        output Cout
);
        wire [3:0] G, P, C;
        assign G = A & B;               //
Generate
        assign P = A ^ B;       // Propagate
        assign C[0] = Cin;
        assign C[1] = G[0] | (P[0] & Cin );
        assign C[2] = G[1] | (P[1] & G[0]) |
(P[1]&P[0]&Cin);
        assign C[3] = G[2] | (P[2] & G[1]) |
(P[2]&P[1]&G[0]) | (P[2]&P[1]&P[0]&Cin);
        assign Cout = G[3] | (P[3] & G[2]) |
(P[3] & G[2] & P[2]) | (P[3]&P[2]&P[1]&G[0]) |
(P[3]&P[2]&P[1]&P[0]&Cin);
        assign Sum = P ^ C;
endmodule
```

```
        input [3:0] exp_sum;
        input exp_cout;
        begin
        #5;  // Wait for combinational logic to
settle
        if ({Cout, Sum} === {exp_cout,
exp_sum}) begin
                $display("PASS: A=%h, B=%h,
Cin=%b | Sum=%h, Cout=%b", A, B, Cin,
Sum, Cout);
        end else begin
                $display("FAIL: A=%h, B=%h,
Cin=%b | Expected: Sum=%h, Cout=%b |
Got: Sum=%h, Cout=%b",
                A, B, Cin, exp_sum, exp_cout,
Sum, Cout);
        end
        end
        endtask

        // Test stimulus
        initial begin
        // Initialize inputs
        A = 0; B = 0; Cin = 0;
        #10;

        // Test Case 1: Basic addition without
carry
        A = 4'h3; B = 4'h4; Cin = 0;
        display_test(4'h7, 0);

        // Test Case 2: Addition with input
carry
        A = 4'h3; B = 4'h4; Cin = 1;
        display_test(4'h8, 0);

        // Test Case 3: Addition causing
output carry
        A = 4'h8; B = 4'h9; Cin = 0;
        display_test(4'h1, 1);

        // Test Case 4: Maximum value test
        A = 4'hF; B = 4'hF; Cin = 1;
```

```
        display_test(4'hF, 1);

        // Test Case 5: Zero value test
        A = 4'h0; B = 4'h0; Cin = 0;
        display_test(4'h0, 0);

        // Test Case 6: Random test cases
        A = 4'h6; B = 4'h7; Cin = 1;
        display_test(4'hE, 0);

        A = 4'hA; B = 4'h5; Cin = 0;
        display_test(4'hF, 0);

        // Test Case 7: Alternating bits
        A = 4'hA; B = 4'h5; Cin = 1;
        display_test(4'h0, 1);

        // Test Case 8: One operand zero
        A = 4'h0; B = 4'hF; Cin = 0;
        display_test(4'hF, 0);

        // End simulation
        #10;
        $display("Simulation completed");
        $finish;
        end

        // Optional: Generate VCD file for
waveform viewing
        initial begin
        $dumpfile("cla_test.vcd");
        $dumpvars(0, OCLA_tb);
        end

endmodule
```


A[3:0]
0
B[3:0]
f
Cin
0
Su...0]
f
Cout
Z
0 3 8 f 0 6 a 0
0 4 9 f 0 7 5 f
0 7 8 1 f 0 e f 0 f
0

Role of Social Media in Religious Discourse and Spiritual Communities

Mohmed Husain Pasheriya | Noyonika Mukherjee

Professor Dr. Barnali Chetia

Course: HS201

Date: 17th November, 2024

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I would also like to thank my friends and colleagues who supported me during the time of research. Their suggestions made me more meticulous towards my ideas and brought in a totally different aspect towards the concerned topic.

Last but not the least, I extend my appreciation to all the 145 respondents who took part in the survey for this study. Every example of their experience and opinion about this material was constructive insight and data input to my study. Without them, this term paper could never be accomplished.

DECLARATION

We, Mohmed Husain Pasheriya and Noyonika Mukherjee, declare that the research paper entitled "The Role of Social Media in Religious Discourse and Spiritual Communities" in partial fulfilment of the HS102 End of Semester Project assigned by Professor Barnali Chetia, is entirely of our own making. Our hypothesis with regard to the same is: *"Exposure to diverse religious opinions on social media challenges and reshapes an individual's traditional beliefs."* To carry out an appropriate investigation of the subject at hand, a thorough study, analysis, and documentation has been conducted.

All the sources of data that have been used in this research study are duly attributed and cited. All the information provided in this paper has been presented with the utmost care for its reliability and accuracy. In addition, all the passages containing information from other sources as well as all the paraphrases and short quotations contain appropriate acknowledgments.

We sign below to attest to the validity of our work and to remark that the contents of this research paper are true to the best of our knowledge.

Mohmed Husain Pasheriya (20235166)

Noyonika Mukherjee (202351167)

Date: 17th November, 2024

ABSTRACT

Social networking sites have turned into spaces where users engage in religious and spiritual conversations while having access to different spiritual communities. This study investigates the impact of social networking sites on religious discussions, with a growing number of users introducing and sharing different practices, and forming expansive online friendships. Such platforms initiate debates which question established beliefs, often making people revise their ideologies and allowing everyone to engage with a variety of faiths and religious practices.

This study evaluates how exposure to a vast range of religious beliefs may act as a counteractive effect on one's pre-existing beliefs. Although it is an accepted fact that social media could aid in compressing the distance between different groups, creating more inclusive and tolerant individuals, and fostering understanding; social media can also lead to confusion and doubt for the users.

The analysis looks at people's interaction with aspects of religion in social networks by means of both e-survey data and offline interviews. It investigates what happens when the members of different faiths attempt to communicate scientifically, virtual or otherwise, with the concepts of civilization in general and community in particular. There is also the provision of analysis and discussions concerning the approach and use of social media to teach marginalized religions.

Nevertheless, the section of the paper that deals with such conversations outlines the difficulties that social media is known to cause. It has been known to worsen situations through the introduction of radical opinions and falsehoods understood by a majority, leading to cognitive dissonance and even disintegration of certain societies, especially in severe cases where religion is a factor. The speed of information diffusion, especially negative aspects and deceit, is irritating as it destroys the prospect of understanding in religion.

In the end, this study seeks to understand a very contemporary problem - the religious conversation in the internet era.

Keywords: social networking sites, religious discussions, spiritual communities, established beliefs, cognitive dissonance, information diffusion.

Table of Contents

List of Figures and Tables

List of Abbreviations

- Fig. – Figure
- AI – Artificial Intelligence
- Tech – Technology
- Dr. – Doctor
- IG – Instagram

Glossary

Polarization – Division of groups or people into completely different and opposing parties

Algorithmic Bias - Systematic and repeatable errors that create unfair outcomes

Cognitive Dissonance – The psychological discomfort one experiences when interacting with someone with conflicting beliefs

Commodification – The process of turning something non-physical but holding some value, like ideas, into a product that can be bought and sold

Chapter – 1

Introduction

In contemporary society, social media has clearly become a game changer for how people access ideas, societies and beliefs. In particular, such media has made it possible for the end users to communicate and engage with any religious or spiritual users across the globe almost instantaneously. This has allowed people to show how different religions are practiced, share ideas and engage in conversations about faith across continents.

On one hand, social networks carry enormous potential to close the barriers and enable engagement between the subjects, while on the other, they raise alarming questions regarding interreligious communication. The exposure to innumerable diverging beliefs and attitudes has raised questions to all religious dogmas and in certain cases caused individuals to transform their personal beliefs and values. Besides, social media is correlated with understanding psychology, and therefore balances the good effects with effects such as false media, propaganda of radical views and the contradiction found by some users in the information concerning religions.

The aim of the research referred to in this study is to explore how the discussions of religion change on social media and what the users of social networks whose are involved in spirituality experience. The results of these interactions will also help us understand the positive impact of social media but also understand the dangers that arise from it.

Focus

This paper aims to discuss the significant role played by social media regarding religious discussions and spiritual communities by exploring how these encourage divergent belief sharing, deconstruction of traditional beliefs, and inclusiveness, thus having a two-edged sword effect on such interactions.

Importance

Understanding how social media influences religious discourse and spiritual communities is a matter of great importance in this interconnected world today. This research addresses a pressing need to analyze the implications of these new platforms within society in regards to faith and belief. Accordingly, this study can inform how social media will allow for approaches to inclusiveness and understanding while working to mitigate the risks presented by misinformation and radicalization. The findings of this study could equally be of value to policymakers, religious leaders, and the internet corporations themselves, based on insights that promote healthier conversations about faith in digital spaces.

Objective of Research

This lays a solid foundation to highlight the many dimensions of social media in shaping religious discourse and impact on spiritual communities; which happens to be the anchor point of this research project. This research provides a critical analysis of the missing pieces in the assessment _ and indeed social structures of the contemporary and historical ethnic psychology. This study will offer meaningful insight in the ways in which social media can be utilized as a tool for promoting tolerance and understanding without the accompanying danger of misinformation and radicalization. And now having that picture, one can see how those very groups are exhausted with fighting with existing faith communities, architects of radicalism, healthy policy, and social network gatekeepers.

Background and Context

This research goes over in detail possible approaches strategies methods dimensions programs schemes and the ways these things affect religious discourse and impact spiritual communities. Presently, this study focuses on how much religion social media may include passive acceptance if not active participation, propagate and share traditional orthodoxy. The study will also explore how these similar sites help in the fostering of contrarian ideologies, wrong information as well as the users' conflicting thoughts. The study also aims to investigate: the composition of virtual spiritual communities, the nature and patterns of interactions within such communities, and as a result how such assessments would they fit

into the idea of social media civicness without it became a dream version of cyberspace but rather striving for realistic adjustment of that modern technical tool.

Research Problem/Hypothesis

Social media has emerged as a significant arena for religious discourse, offering unparalleled access to diverse spiritual practices and ideas. However, this democratization of religious conversations is accompanied by challenges such as the amplification of extreme views and the spread of misinformation. This research examines how these dual dynamics affect individuals and communities, focusing on the evolving role of social media in shaping faith and belief systems.

Our hypothesis is: *Exposure to diverse religious opinions on social media challenges and reshapes an individual's traditional beliefs.*

Chapterisation

Chapter 2 of this research paper focuses on how social media influences the religious conversation and the communities surrounding it. It notes important works and country-wide examples that investigate the relationship between religiosity, social media, and communities. This section gives a brief overview of the topic and figure out the missing parts, which this study seeks to fill.

Chapter 3 is divided into two sections:

• This part deals with the methods used in the process of data collection. Data was collected online by using Google Forms and interviewing people and professionals about media and religion.

• The second section analyzes the data collected, focusing on the impact of exposure to diverse religious opinions on participants' beliefs, attitudes, and behaviours.

Chapter 4 summarizes the research findings and provides conclusions based on the analysis. It discusses the limitations of the study, such as sample diversity and methodological constraints, and suggests directions for future research, including more extensive cross-cultural studies and deeper investigations into social media’s role in shaping religious discourse.

Chapter - 2

Literature Review

Identification of Sources

1. International Academic Studies:

i. "The Vitality of New Media and Religion: Communicative Perspectives, Practices, and Changing Authority in Spiritual Organization" by Cheong, P. H. (2016):
This research seeks to examine the effects of digital platforms on spiritual communication, since new means of interaction are being established and older forms of power relations in the realm of religion are being threatened. Cheong stresses that religious communities use new media for members' mobilization, for network building, and to negotiate power relations. It provides a global perspective on how technology impacts spiritual practices and influences the organization of faith-based groups.

ii. "New Religions in Global Perspective" by Clarke, P. B. (2004):
Clarke examines the diffusion of newer religious movements within the global arena and focuses on the influence of the media in these trends. It outlines methods through which digital tools enable new religious movements to reach wider audiences while changing traditional religious landscapes. Clarke's work further details the significant role the media has played in advancing globalization trends, especially religious movements.

iii. “Exploring the Impact of Social Media on the Religious and Spiritual Beliefs of Emerging Adults" by Ehlebracht, M. (n.d.):
This study investigates how social media influences the religious and spiritual beliefs of young adults, focusing on the transitional life phase known as "emerging adulthood." It outlines and incorporates the contradictory applications of social media for both the persistence of orthodoxy and the contending new beliefs into the growing self-definition of younger age groups.

iv. "The Mediatization of Religion: Theorising Religion, Media, and Social Change" by Hjarvard, S. (2011):
Hjarvard introduces a conceptualization of the process of religion mediatization and considers media as an agent of social change. The research provides an account on the influence of media technology on the practice, rituals and beliefs of religion, thereby altering the aspects of religion and its practice in contemporary society which is media rich.

v. "Social Media as a Platform for Instigating and Waging War" by Ijlsi (2024):
This study assesses social media's role in the context of religious wars and contemporary globalism, stressing the two trends: its use for promoting oneself and one's groups and for waging violence. This analysis shows how such internet communication magnifies radical ideas and promotes drastic actions and modifies the people's minds about particular religions during their clashes.

vi. "Faith and Facebook in a Pluralistic Age" by McClure, P. K. (2016):
McClure analyzes how social networking site 'Facebook' encourages religious activities and bringing people together even in societies that are very diverse. The author points to the argument of the changing scope of religious networks in the social media age showing how this has allowed people to bring together different religions in an effective manner and even live in such societies without fears of violent ethnic confrontations in the modern world.

vii. "Religion and Social Media: Communication Strategies by the Spanish Episcopal Conference" by Baraybar-Fernández, A., Arrufat-Martín, S., & Rubira-García, R. (2020):
This research analyzes the communication strategies employed by the Spanish Episcopal Conference on social media. The study reveals how religious organizations strategically utilize digital platforms to engage followers, disseminate messages, and address societal issues, providing a model for digital religious communication.

viii. "Religion, Popular Culture, and Social Media: The Construction of a Religious Leader Image on Facebook" by Coman, I. A., & Coman, M. (2017):
The authors Coman and Coman examine how clergy perform on social networking sites by combining religious images and popular culture. This research contributes to

the knowledge on the dynamics of religious leaders in the age of social media, where members of the clergy get to preach as well as perform.

2. National Academic Studies

i. "The Impact of Social Media on Religious Tolerance in India: A Case Study on the Digital Discourse in Religious Conflicts" by Ozukum, T. (2021):
This study investigates the role of social media in shaping religious tolerance in India, particularly during conflicts. It explores how digital platforms are the reason behind the spread of different narratives that influence the general public.

ii. "Social Media's Role in the Changing Religious Landscape of Contemporary Bangkok" by Agarwal, R., & Jones, W. J. (2022):
This study is geographically limited to Bangkok but shares the core argument made in the analysis of India, in that it is impossible to avoid the effects of the internet on the way people practice their religion in cities. This reemphasizes a similar point made elsewhere about religious practices in the cities – the old practices fuse seamlessly with the new, modern technologies.

iii. "The Many (Inter)faces of Religious Politics: An Analysis of Social Media Amid Religious and Political Conflict in India" (2024):
This article explores and analyses Indian social media in the light of religion and politics. Focusing upon the digital ecology, it examines how such conflicts are managed, expanded politically, and constructed within the narratives.

iv. "Social Media Fake News in India" by Al-Zaman, M. S. (2021):
This article examines the spread of religious fake news in India, focusing on its impact on societal harmony. The study highlights how misinformation campaigns exploit religious sensitivities, exacerbating tensions and fueling conflicts.

v. "Conflict Between Freedom of Expression and Religion in India—A Case Study" by Singh, A. (2018):
This study analyzes the tension between freedom of expression and religious

sentiments in India, emphasizing the role of social media as both a platform for free speech and a site of religious conflict.

vi. "Digital Divine: Technology Use by Indian Spiritual Sects" by Azhagu Meena, S., et al. (2020):
This study explores how Indian spiritual organizations adopt digital technologies and social media to engage with followers. It highlights the creative and strategic use of these platforms to sustain and expand spiritual practices in a technologically advanced society.

3. Tech Industry Reports:

The reports about the technology industry give a lot of information on social media, technology, and religion. These reports analyze trends, from how a digital user acts to how the future technology will be used in different domains, such as spirituality and religion. For instance, the reports by the major technology companies, including Meta Platforms and Google, often start by stating the increasing role of social media in virtual communities, which encompasses religious groups as well, and the way algorithms shape what users will consume. Customized religious content through the use of artificial intelligence takes center stage in industry insights: apps for the spiritually customized personal life, virtual worship, and scripture analysis through artificial intelligence.

More relevant to the Pew Research Center and other organizations would be the extent to which the digital platform influences, impacts societal values, community engagement, and religious discourse. Such industry reports with their concentration on the metrics of user engagement, strategies of platforms, and technological advancements do a better contextual understanding of how technology mediates religious interaction and reshapes traditional beliefs.

4. Review and Discussion of Sources:

As has been pointed out extensively within academic discourse, social media makes a deep impact as algorithmic biases, misinformation, and echo chambers also shape user engagement with religious content in this era. These dynamics consistently affect interfaith communication; people tend to be absorbed in polarizing narratives while limiting exposure

to diverse perspectives. On the other hand, with the commodification of spiritual discourse, targeted content delivery subtly shapes personal beliefs, raising questions of accountability and transparency. This requires public education and critical involvement in an effort to assist the online discussion of religion in an effective, respectful manner.

5. Conclusion and Recommendation:

From this review of the sources, it can be concluded that social media has various impacts on the individual and the larger society. It is thus crucial that policymakers, industry stakeholders, and individuals take proactive measures toward ensuring digital literacy and placing stricter privacy regulations among other measures that would ensure responsible use of social media. Further research needs to be done on the long-term consequence of using social media to establish control measures over a healthier relationship with social media.

Chapter – 3

Data Analysis

Methodology

Reliability of Sources

1. Primary Data (Google Forms and Offline Interviews): The primary data collected through Google Forms and offline interviews have been relied upon very much in terms of reliability. The survey questions and interview protocols were framed in ways to persuade validity and consistency while collecting data. A sample size of 200+ has ensured diversity within respondents and hence ensures reliability from the findings. Sampling methods and processes of data collection were standardized to avoid possible errors and biases.

2. Secondary data: The sources of secondary data have been scrutinized for reliability, including available academic research and reports from the tech industry. The outputs obtained depend on credible sources that were used in the present study. Data recency has been considered to make sure it is current and relevant for the research questions asked. Subsequently, cross-referencing between secondary data and primary data ensures consistency and reliability in the findings.

Variables Used

Age, Gender, Religious Affiliation, and Use of Social Media: Controlling for all these variables will help determine which demographic factors play a role in people's engrossment in religion online. It looks for any considerable correlation or distinction by establishing patterns of religious discussion among different groups through social media. For example, do age or gender roles play in propelling someone into online religious communities?

Sample Size of over 200: The sample size selected based on statistical considerations was 212 to ensure reliability and generalisation of the findings obtained. In terms of age, gender, and educational background, the sample was heterogeneous, which allowed for comprehensive analysis of the research hypothesis.

Data Collection Procedures

The procedures for collecting both primary and secondary data were planned and conducted in a careful manner to ensure reliability. The questions in the primary data survey were based on established research methodologies and were pre-tested to ensure that they were clear and relevant. The interviews were conducted by trained researchers using standardized protocols to ensure consistency. For secondary data, a systematic approach was followed to identify the sources, and an extraction of data was done based on established guidelines to ensure accuracy.

Data Analysis Techniques

The techniques used in data analysis for this study were selected based on the nature of the data and the nature of the questions under inquiry. For primary data, statistical analysis was considered necessary in order to identify patterns and trends within the data collected. Qualitative data derived from interviews were analyzed through thematic analysis. Secondary data synthesis utilized a systematic review approach in consolidating the evidence from multiple sources.

Reliability of Findings

Overall, the conduct of this study with regards to data collection and analysis is rigorous, supporting the reliability of the findings. Thorough source selection, careful procedures about collecting data, and use of proper techniques while analyzing data account for the reliability of the findings. However, it is worth noting that no study is without limitations, and the findings should be interpreted in the light of its methodology and also any degree of bias.

Regarding our hypothesis -

In this study, we have carefully tested the hypothesis that exposure to diverse religious perspectives on social media challenges and reshapes traditional beliefs. We used a systematic approach to research, consisting of several key components which fit the hypothesis and delivered conclusive findings.

1. **Research Design**: It is a mixed-method approach as a mix of quantitative and qualitative methods were employed. Surveys were used to collect quantitative data about participants' attitudes toward traditional religious beliefs before and after engagement with assorted social media content. Qualitative insight was gathered through in-depth interviews to uncover deeper understandings of the participants' perceptions and experiences.

2. **Data Collection**: In this the survey questionnaire was administered to a sample of 212 participants, and for a portion of the sample, in-depth interviews were held. The survey questions were actually designed to track changes over time in interest, trust, and awareness, while the interviews provided rich, detailed accounts of the experiences and perspectives of participants.

3. **Data Analysis:** Quantitative data obtained from the surveys were analyzed using statistics to identify significant changes in respondents' attitudes before and after watching the documentary. Qualitative interviews were analyzed through thematics to identify common themes and patterns in respondents.

4. **Interpretation of Findings:** Content analysis of both quantitative and qualitative data provided the most comprehensive understanding of how exposure to diverse religious perspectives on social media impacts the beliefs of people in a traditional norm. The results were then interpreted against the hypothesis, namely, belief shifts, openness to alternative perspectives, and reassessment of traditional religious norms.

5. **Google Forms Pie Charts:** Responses to every questionnaire were given in pie charts developed from Google Forms, which were presentations of the spread of responses based on the questions. These charts showed how attitude changes with respect to religious beliefs and practices were fostered by exposure to varied views through social media.

6. **Conclusion and Recommendations:** Based on the analysis, the study concluded that social media significantly challenges and reshapes traditional beliefs by exposing individuals to diverse religious perspectives. We would like to recommend further research that would test these findings on the long-term implications of exposure through such frameworks on religious discourse, community dynamics, and interfaith understanding besides the involvement of algorithms in shaping these interactions.

Our research methodology has therefore been successful in testing the hypothesis and showing a clear connection between the process of research and the hypothesis. Since the methodologies used qualify as a mix of both quantitative and qualitative methods, a comprehensive investigation of research questions has culminated in a holistic conclusion regarding the role social media plays within religious discourse and spiritual communities.

Analysis – I

Online Questionnaire:

Section 1: Demographics

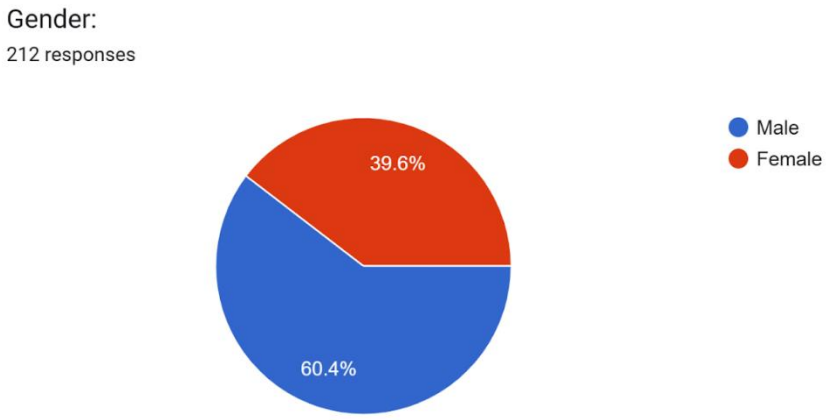


Fig 3. a

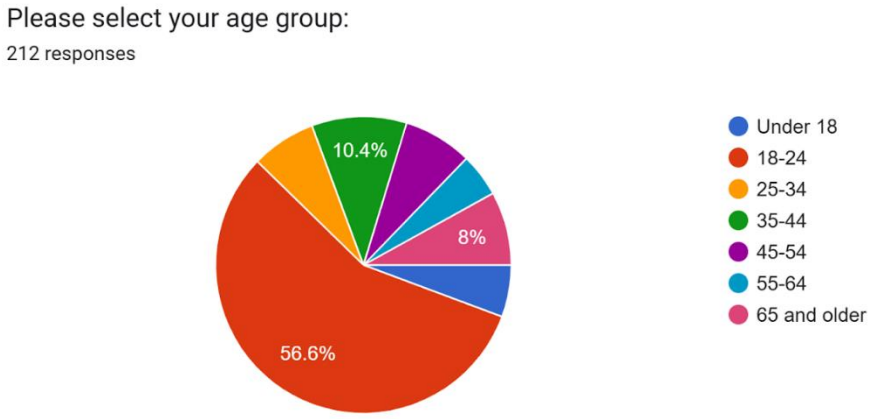


Fig. 3. b

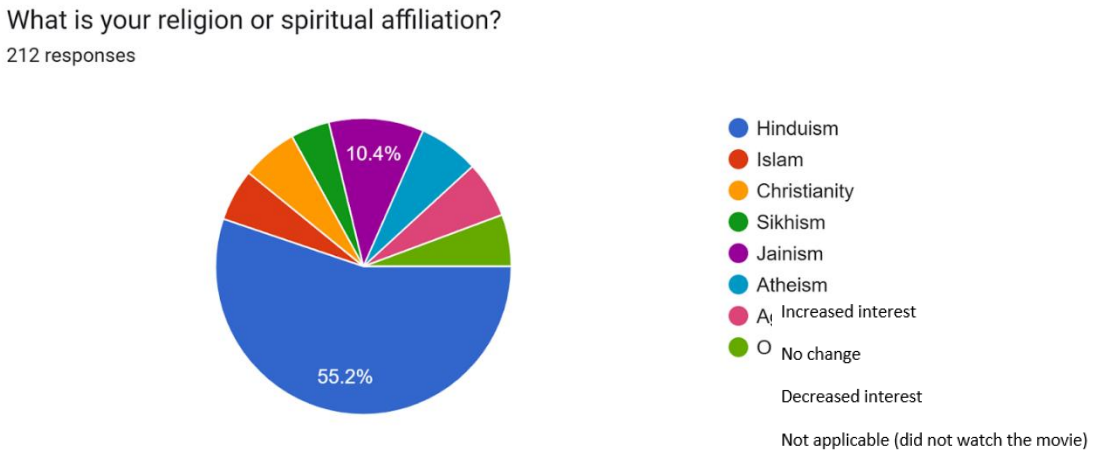
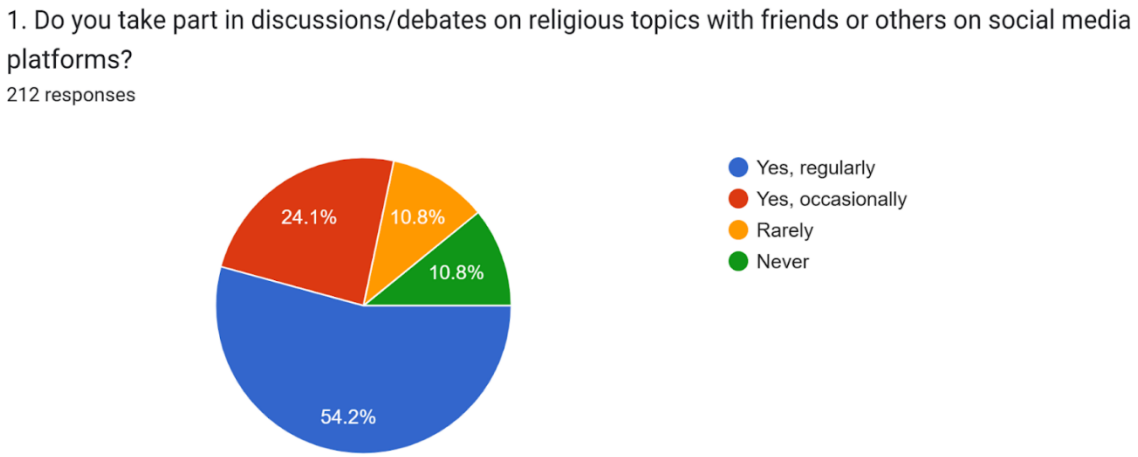


Fig. 3. C

Section 2: Social Media's Role in Religious Dialogue and Challenges

A) Provides compelling evidence that watching documentaries like "The Social Dilemma" increases interest in social media's societal impact, as hypothesized.



A significant majority, 54.2% of respondents, reported that they regularly discuss religious issues on social media. This reflects the hypothesis whereby most of them probably have an active engagement in the discussion about religious topics on the platforms. It shows how this is a rich area of religious discourse for the clients, who engage consistently in such discussions.

A smaller percentage, 24.1% of the respondents, said they often engage in religious debates. This gives more credibility to the hypothesis that social media can be a vehicle for intermittent activity, if not regular activity. This suggests that perhaps people could use social media as one of the channels through which they express their religious opinion once such an occasion or topic arises, but religion is something with which they do not generally seek to engage as some form of entertainment or leisure activity.

10.8% stated that they rarely engage in religious posts on social media. This figure is not central to hypothesis concentration, and it still means that a disproportionately large number of users are being underutilized. The reasons would range from personal issues, lack of time, or perhaps lack of much interest in the discussion of religious matters in the virtual world.

A near similar 10.8% of the respondents claimed to never discuss or engage in religious debates on social media. This finding, although outside of the hypothesis, falls in the rate of the population who either feel that social media should not be an appropriate avenue to discuss religion or would rather not be involved in this at all costs.

Generally, the findings suggest that social media plays a major role in religious discourse, with a large percentage frequently or occasionally participating in these discourses. Thus, this expands the view that social media helps bring meaningful participation into religious debates and further deepens the central position of social media as a resource for communities engaging in modern religious conversation.

B) Provides compelling evidence that social media's role in promoting understanding between different religious communities is perceived positively, but not without reservations.

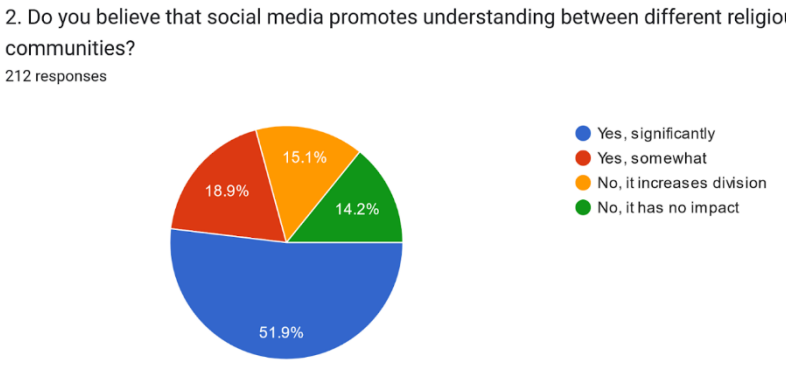


Fig. 4.b

The majority of respondents, 51.9%, believe that social media significantly promotes understanding between different religious communities. This goes a long way in supporting the hypothesis that social media can cause interfaith dialogue and therefore promote mutual understanding. The near-unanimous acceptance of the opinion goes to illustrate that people realize how social media has the potential to knock off barriers and create an avenue for religious communities to share viewpoints that would contribute toward harmonious interaction.

18.9% agreed that social media somewhat promotes understanding between different religious communities. In other words, although it might help in the process of getting to know the other, its impact may be perceived as partial or limited, depending on considerations like the form the social media took, the quality of discussion, or kind of information.

However, 14.2% of them believe that social media exacerbates division between religious communities. Though it is not the majority view, this still exemplifies the types of concerns that social media has led to conflict and misunderstandings. Anonymity and ease of spreading disinformation sometimes assist in aggravating relations between groups.

Only 15.1% of the respondents agreed with the view that social media has not contributed to a better understanding between different religious communities. This can be read in the sense that some people do not see value in online interaction or they feel that these kinds of platforms do not contribute meaningfully to religious discourse.

Overall, it would seem that a great number of people believe the social media phenomenon contributes to understanding among religious communities, although there are still some concerns about whether this platform fosters division or not sufficiently encourages meaningful engagement.

C) Provides compelling evidence that misinformation or extremist content related to religion is a significant issue on social media platforms, according to the survey respondents.

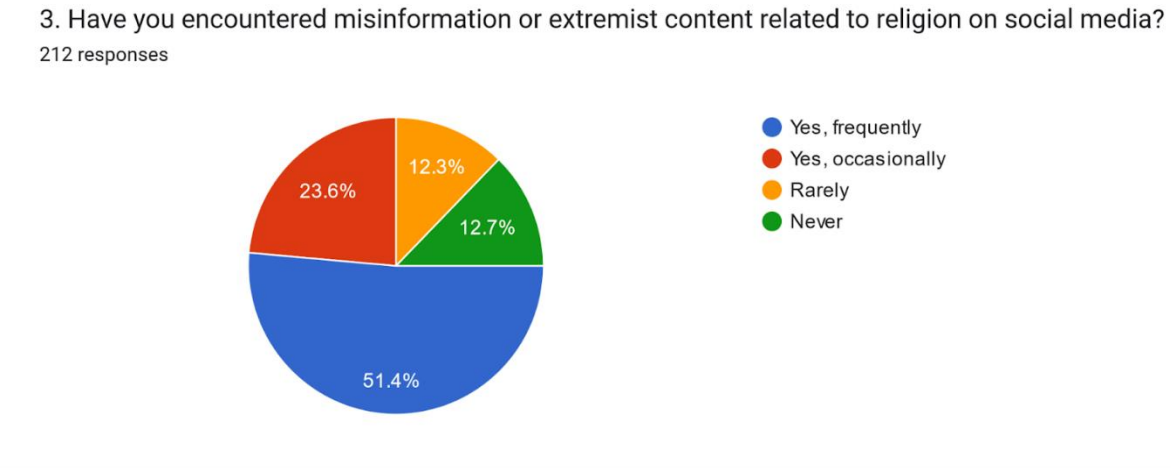


Fig. 4.c

A large proportion, 51.4% of the respondents, reported regularly encountering misinformation or extreme content regarding religion. This is in line with the notion that social media empowers potentially extreme and/or false views, not least in areas such as religion, where sensitive topics are liable to be controversial.

23.6% of the respondents said that they sometimes stumble upon such content. This implies that though misinformation might not be a daily issue for all user interaction, it undoubtedly remains an issue for most listeners. These occasional encounters may draw the attention of the general public to the propaganda being spread in particular areas in cyberspace, such as religious forums or groups in which the content sometimes is not checked.

Only 12.7% said that they rarely stumble on misleading or extremist content related to religion. This might reflect the fact that the problem is not widespread for everyone but always is there, and sometimes users come across misleading or extreme views.

A smaller percentage, 12.3%, claimed never to have seen misleading content or propaganda concerning religion on social networks. Thus, it is likely that for a few users, their experience

with religious material on social media sites would be even more positive or neutral because of less exposure to damaging or misleading information.

However, the results point towards the crucial role disinformation and extremist content on religious issues play on social media since a significantly large number of users (75%) report it at least some of the time. This emphasizes the need for stricter regulation of social media contents and proper engagement with such contents.

D) Supports the hypothesis of social media on understanding and acceptance of different religious perspectives among the respondents.

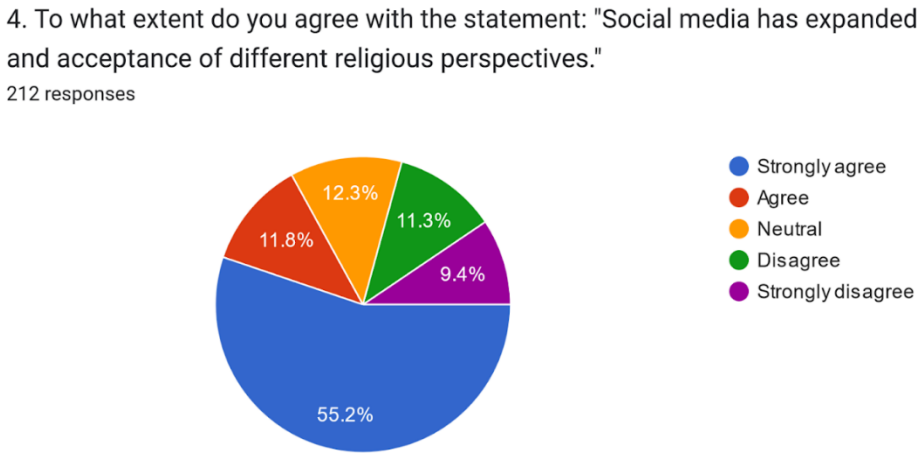


Fig. 4.d

A majority of respondents, 55.2%, believe that that they possessed greater understanding by and exposure to other religious perspectives through social media. So, it would seem that, through social media, the road to awareness and inclusion for different religious views is an effective catalyst. That such a large proportion felt very strongly reflects how online venues contribute to a more tolerant and knowledgeable society.

A smaller yet significant portion, 12.3%, agrees with the statement, further reinforcing the positive influence of social media in shaping perceptions about religious diversity. This group

may not be as enthusiastic as the majority, but they indeed recognize that digital engagement can enhance religious understanding.

11.3% said that they are neutral, which may be because they never experienced and/or were not affected by social media enough seriously to impact their religious stance. Neutrality may only be an indicator of difference in people's usage of social media or the kinds of content these people see and encounter.

On the other hand, 9.4% disagreed with the statement, and 11.8% strongly disagreed. Taken together, these groups constitute of those who consider social media to be detrimental in promoting understanding and acceptance of religious views different from one's own. That might be because of having negative experiences, like seeing polarizing or biased content.

Either way, it supports our hypothesis since it indicates a change from the original perspective of the social media user.

E) Highlights the frequency with which respondents engage with religious or spiritual content on social media platforms.

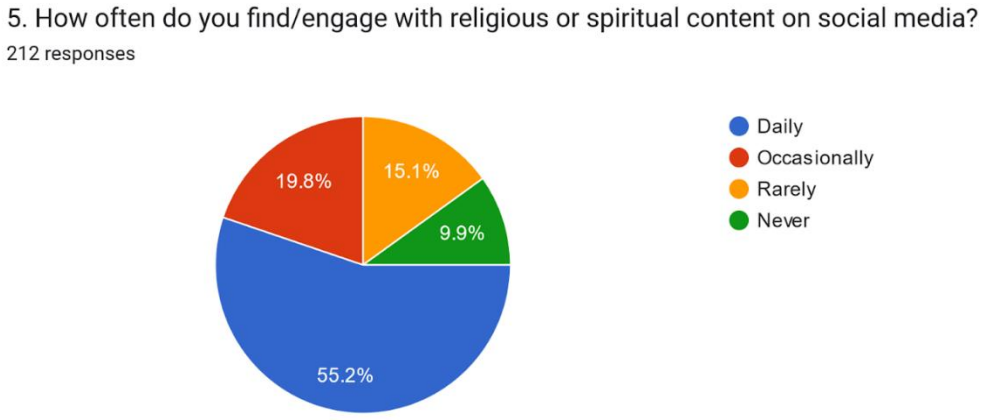


Fig. 4.e

A high number of respondents, that is 55.2%, claimed to interact with religious or spiritual content on social media every day. It means that some significant percentage of users actively consume and engage with such content, showing it is relevant and present in their daily lives.

Almost 19.8% of respondents stated that they occasionally experience religious or spiritual content. This is the population group that does not consciously search for such content but which is yet faced with it through their social media usage; therefore, religious or spiritual content still seems to be present and influential at different engagement levels.

The smallest segment of all, 15.1%, said they hardly used the content. Perhaps this was evidence of disinterest or altogether avoiding religious or spiritual conversations on these sites.

Only 9.9% of respondents said that they never interact with religious or spiritual content on social media. This minority also indicates that although some users may deliberately avoid the topics, the prevalence of religious or spiritual material makes it reach most users to at least some extent.

The underpinnings of findings here underscore the immense importance of social media as an enabler for religious and spiritual discourse, since most respondents have been using this platform frequently. That presents a strong demand for such content perhaps with the ability to shape their beliefs and practices.

G) Explores the influence of diverse religious views on social media in prompting self-reflection on personal religious beliefs among respondents.

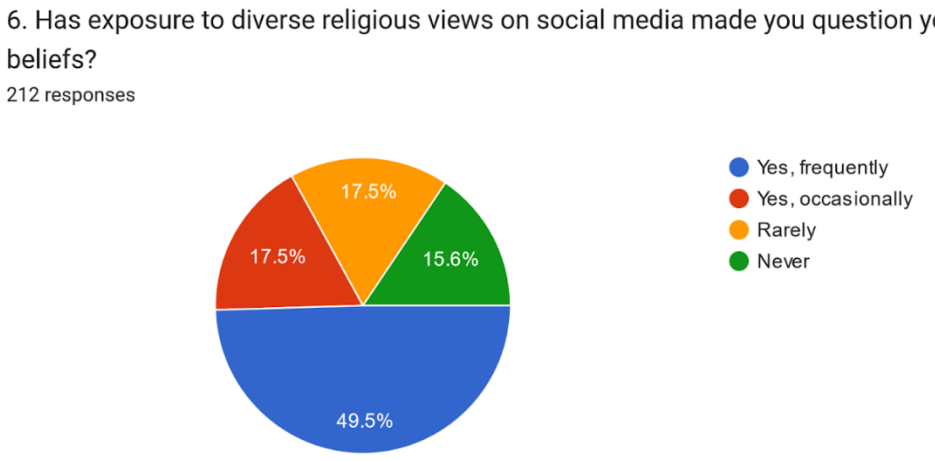


Fig. 5

A majority, 49.5% of respondents self-report how social media exposed them to a variety of religious opinions, and thus made them doubt their own religious beliefs in many instances. That percentage is pretty high, and it definitely means that there's a great contribution of social media towards introspection and re-evaluation of personal views.

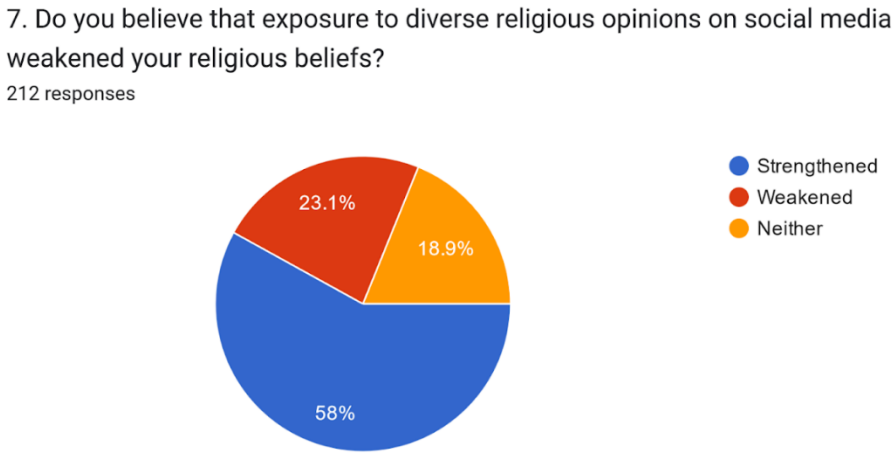
Moreover, 17.5% of respondents said they sometimes doubted their beliefs due to such exposure. Such a group represents the highly significant influence of online religious discourse on personal thoughts and beliefs-there is such an impact because it is always periodic.

17.5% of respondents also stated they rarely question their religious beliefs when encountering diverse viewpoints. This indicated that, although the content may provoke interesting thought, this group has convictions which are not significantly challenged by the content.

Finally, 15.6% of the respondents never questioned their religious beliefs through social media exposure. Thus, for a minority, their beliefs are steady and are not swayed by various perspectives propagated through cyberspaces.

Findings suggest that for a large number of users (84.4%), social media content has the capacity for changing their religious belief systems at least a few times. Meanwhile, they still demonstrate a subgroup of the population who are less sensitive to or even resistant toward influence by such contents, and once again highlight the variability of an individual's response to online materials.

H) Explores the influence of diverse religious views on social media on the strength of respondents' personal religious beliefs.



A large number of the respondents, 58%, believe that exposure to diverse religious views on social media has strengthened their religious beliefs. This is an important figure as it reveals social media as a reinforcing agent that could affirm and even congeal prior convictions when everyone is exposed to a diversity of views.

In fact, 23.1% agreed that their beliefs have been weakened because of this exposure. This is reflective of how social media expositions can be disruptive to personal religious convictions and the viewpoint exposure it provides.

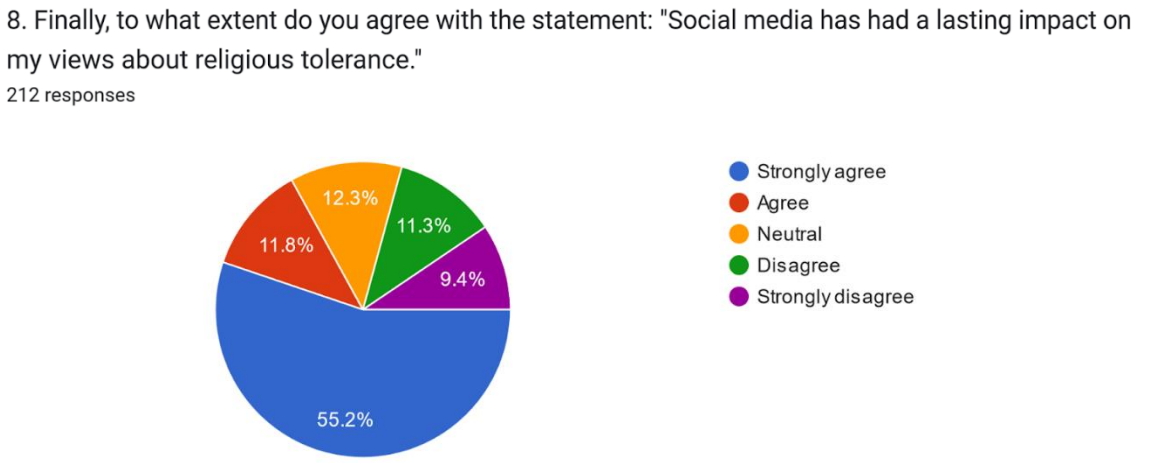
Interestingly, 18.9% said they maintained the same beliefs after interacting with different religious thoughts. This means that for a number of respondents, their beliefs are either robust or do not shift with regard to religious eloquence found online.

The findings indicate that social media functions as a tool both to reaffirm religious belief and more frequently and/or significantly as a factor to question or even weaken them, underlining the broad and multifaceted impact of social media on individual beliefs.

Overall, 81.1% of the respondents have had their spiritual stances strengthening or weakening, thus supporting our hypothesis that exposure to social media results in a change in their original beliefs.

Section 3: Conclusion

A) Strongly supports the original hypothesis of the influence of social media on shaping respondents' views about religious tolerance.



More than half the users undoubtedly agreed that social media has brought upon changes in views related to religious tolerance. This big proportion puts across the powerful role of social media in availing avenues through which people could discuss religion and even maybe increase understanding and acceptance of diverse religious perspectives.

11.8% answered in the affirmative of the statement and brings out how social media can be used as a tool to forward positive contributions toward tolerance. Putting these two groups together implies that most use social media instrumentally in opinion formation on this question.

However, 12.3% were neutral, meaning that though social media may expose people to differences in opinion, the resultant effect on their perception of religious tolerance is unclear.

Only 11.3% respondents had disagreed with the statement; meaning that for some, either social media has no special influence or possibly even perpetuates pre-existing attitudes regarding religious tolerance. However, this constitutes of the minority.

The findings indicate social media plays a significant role in shaping attitudes toward religious tolerance for the majority of users but also show that a part of society appears to be impervious or even critical of such influence.

Conclusion:

As the online survey is analysed, it becomes clear that social media forms an important vehicle of modern religious discourse and personal expression. Social media are, indeed, found to be a dynamic forum in which people actively communicate on religious matters, with most respondents either fairly often or sometimes taking part. These platforms appear to play an instrumental role for interfaith understanding and acceptance; though the fears of social media's potential for promoting division and misinformation endure.

The findings underpin the double-edged nature of the influence social media exercises over society: while it allows people to understand ideas better and to make their beliefs stronger for many, it contradicts convictions for others. Again, the ubiquitousness and potential for reflection of religious and spiritual content on digital platforms further highlight just how transformative their impact can be on personal faith and collective religious discourse. Still, the spread of misinformation and hate speech here presupposes responsible content moderation and critical engagement by users. In general, social media is a powerful though complex instrument for shaping religious attitudes and developing interfaith relationships in the digital world.

Analysis – II

Offline questionnaire

Interviewer: Thank you for participating in our survey. We're interested in understanding how social media is shaping religious belief, practice, and interfaith understanding. So, let's start with your own experience. Which of the following social media apps do you use to consume content related to your religion?

Interviewee: I mostly look for religious content on either Instagram and YouTube. Sometimes I even scan the threads on Twitter for specific topics.

Interviewer: That's great to hear. In what ways do you feel that social networking services have motivated you to appreciate your religion and its practices more?

Interviewee: Social media has made it easier to access teachings, sermons, and rituals that I never knew about. And by watching videos or reading posts by scholars, I began to appreciate faith.

Interviewer: That's interesting. How many times have you found social media to clarify any misconceptions about your own religion? Take an example from your past experiences.

Interviewee: Yes, I had one point of misunderstanding the historical context of a particular previously practiced ritual in my religion (Sati). One day while browsing on IG, I read one very detailed posting from a scholar, and it cleared up things for me.

It's definitely made me more curious about the societal impacts of social media. I find myself reading more about different subjects and discussing it with friends.

Interviewer: That is amazing. Have you ever seen something on social media that you felt was false about your religion or spirituality? How did that affect you?

Interviewee: Absolutely. I do see many posts spreading false information about a ritual or a value, often made by some individuals trying to spread hate. It is frustrating and sometimes creates confusion, but it also challenges me to verify facts further and look for authentic sources.

Interviewer: And talking of authenticity, how do you differentiate between credible and non-credible content related to your faith online?

Interviewee: I look out for posts from verified scholars, religious leaders or organisations. I cross-check the information with official sources or some of the most trusted religious texts.

Interviewer: Thank you for sharing your insights. Now, let's speak about other religions. Have you ever corrected a stereotype about another religion that you encountered on social media? Have your attitudes or standpoints changed?

Interviewee: If I think about it, I have had corrected several misconceptions in online discussions. Learning directly from people of other faiths has made me more open-minded and respectful towards their beliefs. I learned to discover common values in religion, such as compassion and justice. It's great that they share similar central messages despite how diverse they are with their spirituality.

Interviewer: Thank you for your insights. One last question; in your opinion, do you believe that social media is mainly having a positive or negative influence on people's religions or faiths? Why?

Interviewee: I feel like it’s a mix. It’s a good thing because it spreads knowledge and creates connections, but it can also be harmful if misinformation or extremist content isn’t addressed properly.

Interviewer: Thank you for participating in our survey and giving us your opinions regarding this topic. Your standpoint is really helpful for discussing the impact of social media on religious discourse and mutual understanding among religions.

Conclusion

In conclusion, this study confirmed how social media has a huge impact on religious discourse and spiritual communities, validating our hypothesis. Social media algorithms tend to cause the phenomenon of echo chambers with intense polarizing narratives in their proliferations, limit exposure to diversified views, and make constructive interfaith dialogue impossible. Furthermore, subtle manipulation of personal beliefs with content delivery raises ethical concerns about the manipulation of spiritual interactions. Nonetheless, opportunities for fostering connection and dialogue among diverse religious communities continue to abound in social media.

This scope of this research through transparency, ethical accountability, and public education can minimize the effects of social media on spiritual engagement. Critical media literacy practices and inclusive content moderation strategies create spaces where mutual respect and understanding of religious conversations are fostered. These measures are critical to taking full advantage of the positive potential of social media while acknowledging its challenges.

However, the study is limited by the fast-changing nature of social media technologies and the diversity of user experiences across cultural and religious contexts. Of course, it would be interesting to explore what emerging new platforms and AI-driven technologies do for religious practices and whether belief systems change in the long term as a result of the content exposed on social media. By expanding these dimensions of study, a deeper understanding of how social media interacts with spirituality can be attained which will lead to greater ethical and inclusive online religious groups.

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Appendices

Appendix I: Online Survey Questionnaire

Role of Social Media in Religious Discourse and Spiritual Communities

Thank you for participating in this survey. The focus of this research is the effect of social networks on religion and spirituality. We recognize the role of social media in religious discussions today as a very important medium that allows a variety of opinions that at times contradict existing beliefs. Your answers will allow us to assess how looking at different religions on the Internet influences people's outlook and promotes interreligious communication as well as confrontation with fake news and divisions. By filling out the given questionnaire, you will help us learn how the use of social network services in religion and spirituality has been changing over the last few years.

* Indicates required question

Section 1: Demographics and Social Media Usage

1. Full name: *

2. Gender: *

Mark only one oval.

- ◯ Male
- ◯ Female
- ◯ Other
- ◯ Prefer not to say

3. Please select your age group: *

Mark only one oval.

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65 and older

4. What is your religion or spiritual affiliation? *

Mark only one oval.

- ◯ Hinduism
- ◯ Islam
- ◯ Christianity
- ◯ Sikhism
- ◯ Jainism
- ◯ Atheism
- ◯ Agnosticism
- ◯ Other

Section 2: Social Media's Role in Religious Dialogue and Challenges

5. 1. Do you take part in discussions/debates on religious topics with friends or others on social media platforms? *

Mark only one oval.

- ◯ Yes, regularly
- ◯ Yes, occasionally
- ◯ Rarely
- ◯ Never

6. 2. Do you believe that social media promotes understanding between different religious communities? *

Mark only one oval.

- ◯ Yes, significantly
- ◯ Yes, somewhat
- ◯ No, it increases division
- ◯ No, it has no impact

7. 3. Have you encountered misinformation or extremist content related to religion on social media? *

Mark only one oval.

- ◯ Yes, frequently
- ◯ Yes, occasionally
- ◯ Rarely
- ◯ Never

Section 3: Impact on Personal Beliefs

8. To what extent do you agree with the statement: "Social media has expanded my understanding and acceptance of different religious perspectives." *

Mark only one oval.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

9. How often do you find/engage with religious or spiritual content on social media? *

Mark only one oval.

- ◯ Daily
- ◯ Occasionally
- ◯ Rarely
- ◯ Never

10. Has exposure to diverse religious views on social media made you question your own religious beliefs? *

Mark only one oval.

- ◯ Yes, frequently
- ◯ Yes, occasionally
- ◯ Rarely
- ◯ Never

11. Do you believe that exposure to diverse religious opinions on social media has strengthened or weakened your religious beliefs? *

Mark only one oval.

- ◯ Strengthened
- ◯ Weakened
- ◯ Neither

12. Finally, to what extent do you agree with the statement: "Social media has had a lasting impact on my views about religious tolerance." *

Mark only one oval.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neutral
- ◯ Disagree
- ◯ Strongly disagree

Appendix II: Offline Survey Questionnaire

Questions Related to the Person's Own Religion:

1) Which social media apps do you use to consume content related to your religion?
2) In what ways do you think social networking services motivated you to appreciate your religion and its practices more?
3) 3. Have you ever found clarity about any misconceptions you had about your own religion through social media? Can you share an example?
4) 4. Have you ever seen anything on social media that you believe is false concerning your religion and spirituality? What effect did that have on you, if any?
5) 5. How do you differentiate between reliable and unreliable content about your faith on social media?

Questions Related to Other Religions:

1) Have you ever met or corrected the stereotypes about the other religions that you have seen previously on social media? Did your attitude or standpoint change?
2) What new insights or teachings have you learned about other religions through social media, that are worth mentioning?
3) Do you think social media enhances understanding and tolerance among different religions? Why or why not?
4) Have you engaged in any online discussions or debates regarding religion with people from different faiths? What was the outcome?

General Questions:

1) Do you follow any spiritual leaders (offline/online)? If so, which ones and why?
2) In your view, do you think that social media have a good or a bad effect on people's religious beliefs and practices? Give reasons.

Sample Response

Role of Social Media in Religious Discourse and Spiritual Communities

Thank you for participating in this survey. The focus of this research is the effect of social networks on religion and spirituality. Your answers will allow us to assess how looking at different religions on the Internet influences people's outlook and promotes interreligious communication as well as confrontation with fake news and divisions. By filling out the given questionnaire, you will help us learn how the use of social network services in religion and spirituality has been changing over the last few years.

Created by: Noyonika Mukherjee and Mohmed Husain

202351167@iiitvadodara.ac.in Switch account

Not shared

Draft saved

* Indicates required question

Section 1: Demographics and Social Media Usage

Full name: *

Noyonika Mukherjee

Gender: *

- ○ Male
- ◉ Female

Please select your age group: *

- ○ Under 18
- ◉ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65 and older

What is your religion or spiritual affiliation? *

- ◉ Hinduism
- ○ Islam
- ○ Christianity
- ○ Sikhism
- ○ Jainism
- ○ Atheism
- ○ Agnosticism
- ○ Other

Section 2: Social Media's Role in Religious Dialogue and Challenges

1. Do you take part in discussions/debates on religious topics with friends or others on social media platforms? *

- ○ Yes, regularly
- ◉ Yes, occasionally
- ○ Rarely
- ○ Never

2. Do you believe that social media promotes understanding between different religious communities? *

- ○ Yes, significantly
- ◉ Yes, somewhat
- ○ No, it increases division
- ○ No, it has no impact

3. Have you encountered misinformation or extremist content related to religion on social media? *

- ◉ Yes, frequently
- ○ Yes, occasionally
- ○ Rarely
- ○ Never

Section 3: Impact on Personal Beliefs

4. To what extent do you agree with the statement: "Social media has expanded my understanding and acceptance of different religious perspectives." *

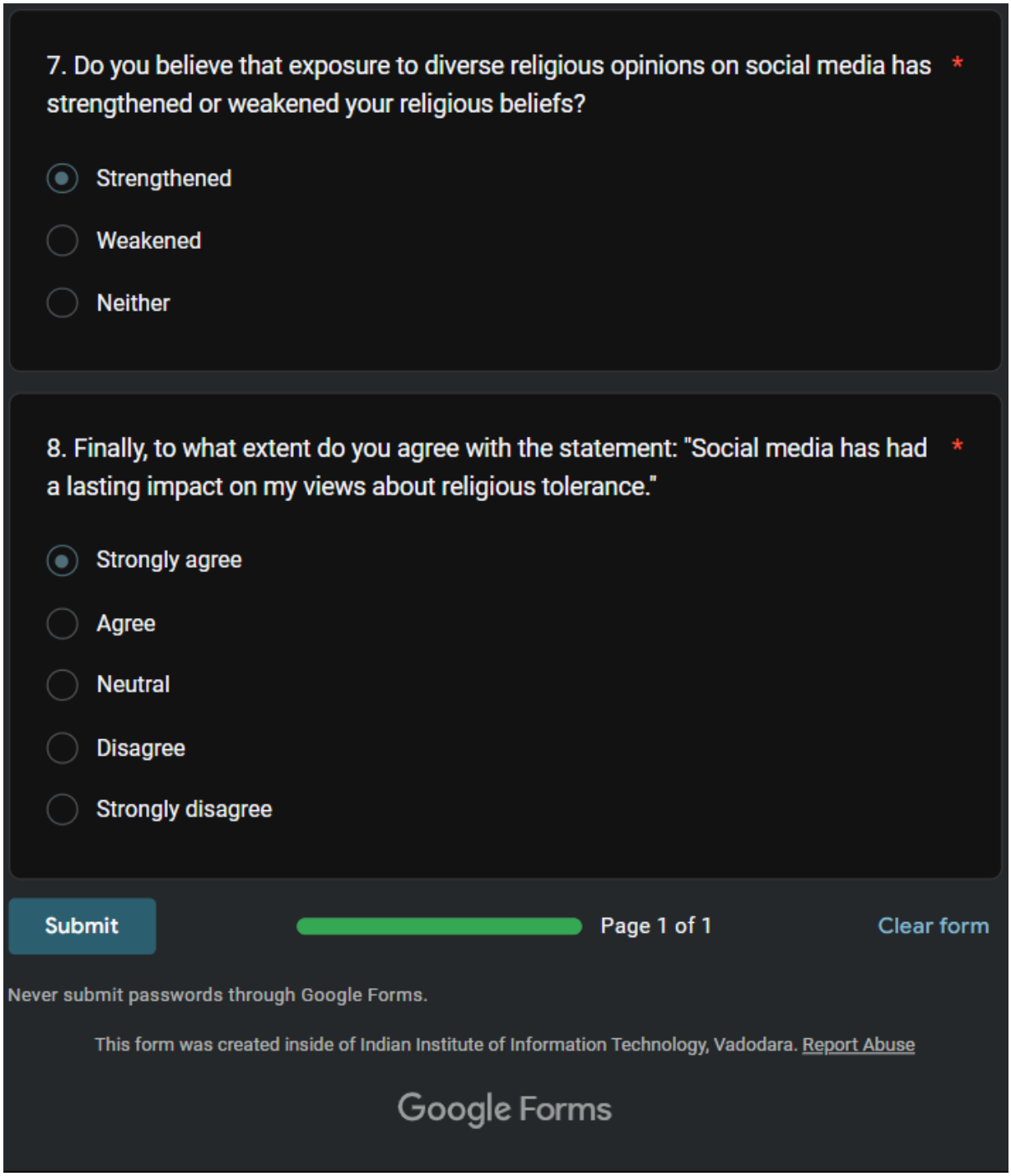
- (●) Strongly agree
- ( ) Agree
- ( ) Neutral
- ( ) Disagree
- ( ) Strongly disagree

5. How often do you find/engage with religious or spiritual content on social media? *

- ( ) Daily
- (●) Occasionally
- ( ) Rarely
- ( ) Never

6. Has exposure to diverse religious views on social media made you question your own religious beliefs? *

- (●) Yes, frequently
- ( ) Yes, occasionally
- ( ) Rarely
- ( ) Never


7. Do you believe that exposure to diverse religious opinions on social media has strengthened or weakened your religious beliefs? *
Strengthened
Weakened
Neither
8. Finally, to what extent do you agree with the statement: "Social media has had a lasting impact on my views about religious tolerance." *
Strongly agree
Agree
Neutral
Disagree
Strongly disagree
Submit
Page 1 of 1
Clear form
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This form was created inside of Indian Institute of Information Technology, Vadodara. Report Abuse
Google Forms

LAB 1

Main:

```
//NAME = UDAY SINGH ID = 202351150
//NAME = SHIVAM KUMAR ID=202351130
// Logic Gates Module (Structural Model)
module logic_gates(
   input wire A, B,
   output wire AND_out, OR_out, NOT_A_out, NAND_out, NOR_out, XOR_out
);

// AND gate
and u1 (AND_out, A, B);

// OR gate
```

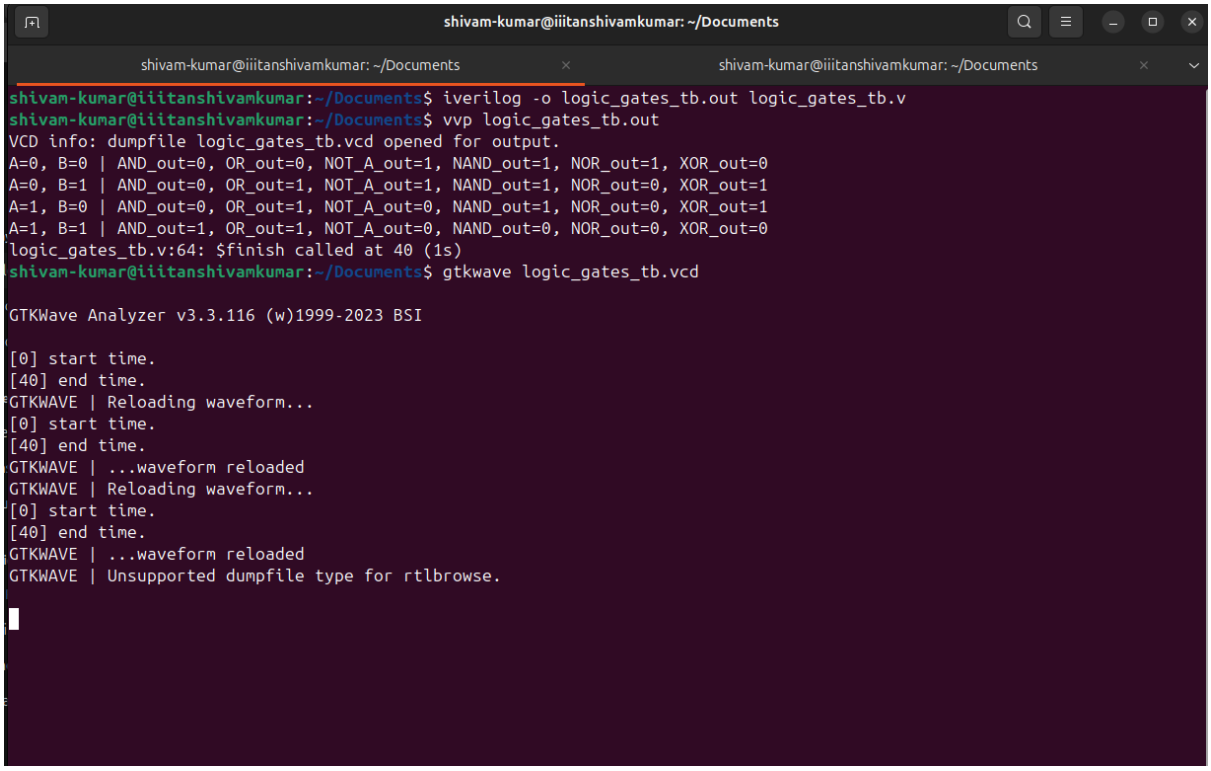
```
or u2 (OR_out, A, B);

// NOT gate (for input A)
not u3 (NOT_A_out, A);

// NAND gate
nand u4 (NAND_out, A, B);

// NOR gate
nor u5 (NOR_out, A, B);

// XOR gate
xor u6 (XOR_out, A, B);

endmodule
```

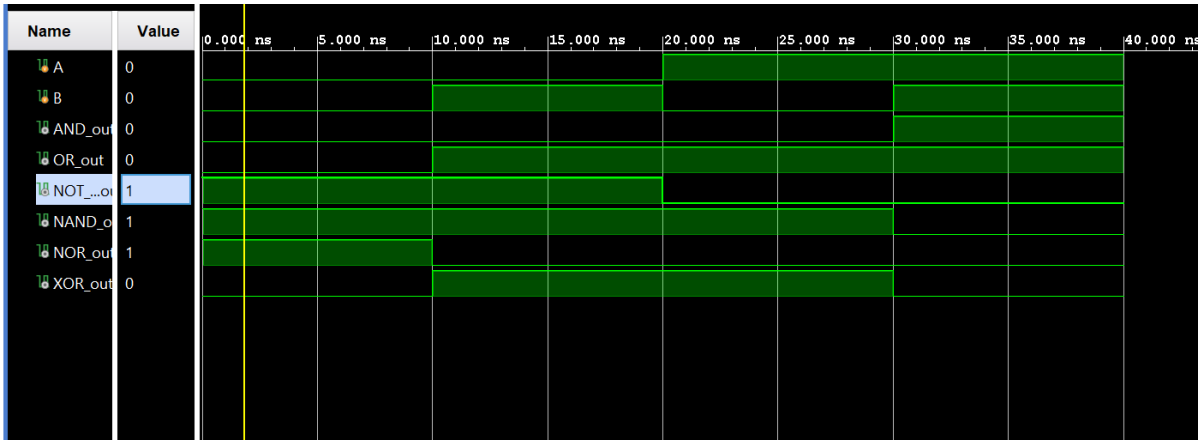
test bench

```
// Testbench to apply stimulus and check outputs
module testbench;

// Testbench signals
reg A, B;
wire AND_out, OR_out, NOT_A_out, NAND_out, NOR_out, XOR_out;

// Instantiate the logic_gates module (Unit Under Test - UUT)
logic_gates uut (
    .A(A),
    .B(B),
    .AND_out(AND_out),
    .OR_out(OR_out),
    .NOT_A_out(NOT_A_out),
    .NAND_out(NAND_out),
    .NOR_out(NOR_out),
    .XOR_out(XOR_out)
);

// Test stimulus
initial begin

    // Monitor the outputs whenever A or B changes
    $monitor("A=%b, B=%b | AND_out=%b, OR_out=%b, NOT_A_out=%b,
NAND_out=%b, NOR_out=%b, XOR_out=%b",
```

```
        A, B, AND_out, OR_out, NOT_A_out, NAND_out, NOR_out, XOR_out);

    // Apply test cases
    A = 0; B = 0; #10; // Test case 1
    A = 0; B = 1; #10; // Test case 2
    A = 1; B = 0; #10; // Test case 3
    A = 1; B = 1; #10; // Test case 4

    // Finish the simulation
    $finish;
end

endmodule
```

Output


shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar:~/Documents$ iverilog -o logic_gates_tb.out logic_gates_tb.v
shivam-kumar@iiitanshivamkumar:~/Documents$ vvp logic_gates_tb.out
VCD info: dumpfile logic_gates_tb.vcd opened for output.
A=0, B=0 | AND_out=0, OR_out=0, NOT_A_out=1, NAND_out=1, NOR_out=1, XOR_out=0
A=0, B=1 | AND_out=0, OR_out=1, NOT_A_out=1, NAND_out=1, NOR_out=0, XOR_out=1
A=1, B=0 | AND_out=0, OR_out=1, NOT_A_out=0, NAND_out=1, NOR_out=0, XOR_out=1
A=1, B=1 | AND_out=1, OR_out=1, NOT_A_out=0, NAND_out=0, NOR_out=0, XOR_out=0
logic_gates_tb.v:64: $finish called at 40 (1s)
shivam-kumar@iiitanshivamkumar:~/Documents$ gtkwave logic_gates_tb.vcd
GTKWave Analyzer v3.3.116 (w)1999-2023 BSI
[0] start time.
[40] end time.
GTKWAVE | Reloading waveform...
[0] start time.
[40] end time.
GTKWAVE | ...waveform reloaded
GTKWAVE | Reloading waveform...
[0] start time.
[40] end time.
GTKWAVE | ...waveform reloaded
GTKWAVE | Unsupported dumpfile type for rtlbrowse.


Name
Value
A
0
B
0
AND_out
0
OR_out
0
NOT_...
1
NAND_o
1
NOR_out
1
XOR_out
0
0.000 ns
5.000 ns
10.000 ns
15.000 ns
20.000 ns
25.000 ns
30.000 ns
35.000 ns
40.000 ns

Lab2

Main:

```
// Logic Gates Using Behavioral Model
module logic_gates_behavioral(
   input wire A, B,
   output wire NOT_A_NAND, AND_NAND, OR_NAND, XOR_NAND, XNOR_NAND, NOR_NAND, NAND_NAND,
   output wire NOT_A_NOR, AND_NOR, OR_NOR, XOR_NOR, XNOR_NOR, NAND_NOR
);

   // *** Behavioral Model for Gates Using NAND ***

   // NOT using NAND
   assign NOT_A_NAND = ~A;

   // AND using NAND
   assign AND_NAND = A & B;

   // OR using NAND
   assign OR_NAND = A | B;

   // XOR using NAND
   assign XOR_NAND = A ^ B;

   // XNOR using NAND
```

```
    assign XNOR_NAND = ~(A ^ B);

    // NOR using NAND (Behavioral implementation of NOR using NAND gates logic)
    assign NOR_NAND = ~(A | B);

    // NAND gate itself (already implemented by NAND gate)
    assign NAND_NAND = ~(A & B);

    // *** Behavioral Model for Gates Using NOR ***

    // NOT using NOR
    assign NOT_A_NOR = ~A;

    // AND using NOR (Behavioral implementation of AND using NOR gates logic)
    assign AND_NOR = A & B;

    // OR using NOR
    assign OR_NOR = A | B;

    // XOR using NOR
    assign XOR_NOR = A ^ B;

    // XNOR using NOR
    assign XNOR_NOR = ~(A ^ B);
```

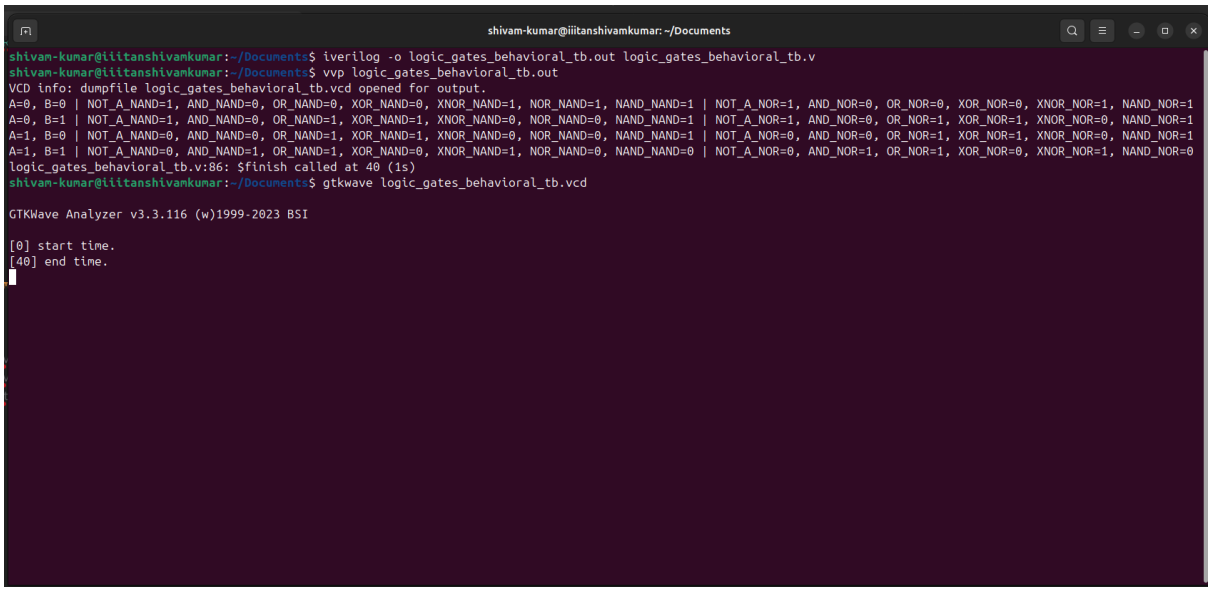
```
    // NAND using NOR (Behavioral implementation of NAND using NOR gates
logic)
    assign NAND_NOR = ~(A & B);


endmodule
```

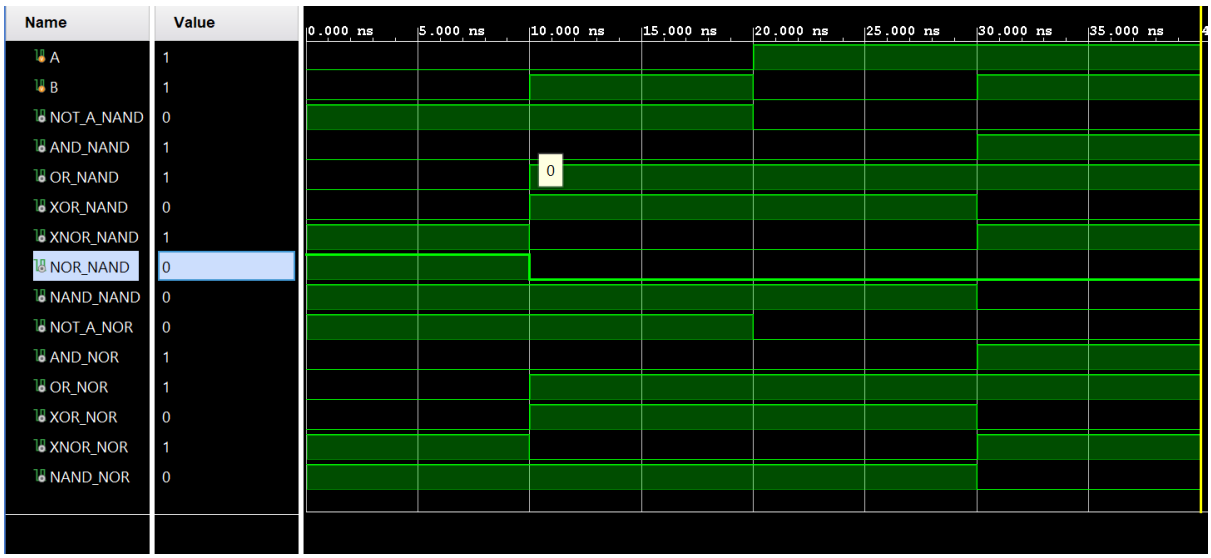
testbench:

```
// Testbench to check outputs with VCD generation

module testbench;


   // Testbench signals

   reg A, B;

   wire NOT_A_NAND, AND_NAND, OR_NAND, XOR_NAND, XNOR_NAND, NOR_NAND,
NAND_NAND;

   wire NOT_A_NOR, AND_NOR, OR_NOR, XOR_NOR, XNOR_NOR, NAND_NOR;


   // Instantiate the logic_gates_behavioral module

   logic_gates_behavioral uut (

      .A(A), .B(B),

      .NOT_A_NAND(NOT_A_NAND), .AND_NAND(AND_NAND), .OR_NAND(OR_NAND),
.XOR_NAND(XOR_NAND), .XNOR_NAND(XNOR_NAND), .NOR_NAND(NOR_NAND),
.NAND_NAND(NAND_NAND),

      .NOT_A_NOR(NOT_A_NOR), .AND_NOR(AND_NOR), .OR_NOR(OR_NOR),
.XOR_NOR(XOR_NOR), .XNOR_NOR(XNOR_NOR), .NAND_NOR(NAND_NOR)

   );


   // Test stimulus

   initial begin

      // Create a VCD file

      $dumpfile("logic_gates_behavioral_tb.vcd"); // VCD file name

      $dumpvars(0, testbench); // Dump variables from the testbench module


      // Monitor the outputs

      $monitor("A=%b, B=%b | NOT_A_NAND=%b, AND_NAND=%b, OR_NAND=%b,
XOR_NAND=%b, XNOR_NAND=%b, NOR_NAND=%b, NAND_NAND=%b | NOT_A_NOR=%b,
AND_NOR=%b, OR_NOR=%b, XOR_NOR=%b, XNOR_NOR=%b, NAND_NOR=%b",
```

```
        A, B, NOT_A_NAND, AND_NAND, OR_NAND, XOR_NAND, XNOR_NAND,
NOR_NAND, NAND_NAND, NOT_A_NOR, AND_NOR, OR_NOR, XOR_NOR, XNOR_NOR,
NAND_NOR);

    // Apply test cases
    A = 0; B = 0; #10;
    A = 0; B = 1; #10;
    A = 1; B = 0; #10;
    A = 1; B = 1; #10;

    // Finish the simulation
    $finish;
  end

endmodule



//iverilog -o logic_gates_behavioral_tb.out logic_gates_behavioral_tb.v
//vvp logic_gates_behavioral_tb.out
//gtkwave logic_gates_behavioral_tb.vcd
```

Output:


shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar:~/Documents$ iverilog -o logic_gates_behavioral_tb.out logic_gates_behavioral_tb.v
shivam-kumar@iiitanshivamkumar:~/Documents$ vvp logic_gates_behavioral_tb.out
VCD info: dumpfile logic_gates_behavioral_tb.vcd opened for output.
A=0, B=0 | NOT_A_NAND=1, AND_NAND=0, OR_NAND=0, XOR_NAND=0, XNOR_NAND=1, NOR_NAND=1, NAND_NAND=1 | NOT_A_NOR=1, AND_NOR=0, OR_NOR=0, XOR_NOR=0, XNOR_NOR=1, NAND_NOR=1
A=0, B=1 | NOT_A_NAND=1, AND_NAND=0, OR_NAND=1, XOR_NAND=1, XNOR_NAND=0, NOR_NAND=0, NAND_NAND=1 | NOT_A_NOR=1, AND_NOR=0, OR_NOR=1, XOR_NOR=1, XNOR_NOR=0, NAND_NOR=1
A=1, B=0 | NOT_A_NAND=0, AND_NAND=0, OR_NAND=1, XOR_NAND=1, XNOR_NAND=0, NOR_NAND=0, NAND_NAND=1 | NOT_A_NOR=0, AND_NOR=0, OR_NOR=1, XOR_NOR=1, XNOR_NOR=0, NAND_NOR=1
A=1, B=1 | NOT_A_NAND=0, AND_NAND=1, OR_NAND=1, XOR_NAND=0, XNOR_NAND=1, NOR_NAND=0, NAND_NAND=0 | NOT_A_NOR=0, AND_NOR=1, OR_NOR=1, XOR_NOR=0, XNOR_NOR=1, NAND_NOR=0
logic_gates_behavioral_tb.v:86: $finish called at 40 (1s)
shivam-kumar@iiitanshivamkumar:~/Documents$ gtkwave logic_gates_behavioral_tb.vcd
GTKWave Analyzer v3.3.116 (w)1999-2023 BSI
[0] start time.
[40] end time.


Name
Value
A 1
B 1
NOT_A_NAND 0
AND_NAND 1
OR_NAND 1
XOR_NAND 0
XNOR_NAND 1
NOR_NAND 0
NAND_NAND 0
NOT_A_NOR 0
AND_NOR 1
OR_NOR 1
XOR_NOR 0
XNOR_NOR 1
NAND_NOR 0
0.000 ns
5.000 ns
10.000 ns
15.000 ns
20.000 ns
25.000 ns
30.000 ns
35.000 ns
0

Lab 3:

Main:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 19.09.2024 18:07:47
// Design Name:
// Module Name: HALF_ADDER
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
```

```
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////
// NAME = UDAY SINGH ,ROLL NO = 202351150  || NAME = SHIVAM KUMAR, ROLL NO = 202351130
module HALF_ADDER(
    input A,
    input B,
    output SUM,
    output CARRY
    );
    xor(SUM,A,B);
    and(CARRY,A,B);
endmodule
testbench:
// Testbench for Half Adder with VCD for GTKWave
module testbench;
```

```
    // Testbench signals
    reg A, B;           // Inputs to the half adder
    wire SUM, CARRY;    // Outputs from the half adder

    // Instantiate the half_adder module
    half_adder uut (
        .A(A),
        .B(B),
        .SUM(SUM),
        .CARRY(CARRY)
    );

    // Test stimulus
    initial begin
        // Open a VCD file for GTKWave
        $dumpfile("half_adder.vcd");  // Specify the name of the VCD file
        $dumpvars(0, testbench);      // Dump all variables for the module 'testbench'

        // Monitor the inputs and outputs
```

```
        $monitor("A=%b, B=%b | SUM=%b, CARRY=%b",
A, B, SUM, CARRY);

        // Apply test cases
        A = 0; B = 0; #10;  // Test case 1: 0 + 0
        A = 0; B = 1; #10;  // Test case 2: 0 + 1
        A = 1; B = 0; #10;  // Test case 3: 1 + 0
        A = 1; B = 1; #10;  // Test case 4: 1 + 1

        // Finish the simulation
        $finish;
    end

endmodule



//iverilog -o half_adder_tb.out half_adder_tb.v
half_adder.v
//vvp half_adder_tb.out
//gtkwave half_adder.vcd
```

Main_fulladder:

```
// Full Adder module
module full_adder(
    input wire A,    // First input
    input wire B,    // Second input
    input wire Cin,  // Carry-in input
    output wire Sum,  // Sum output
    output wire Cout  // Carry-out output
);

// Intermediate values for half-adders
wire Sum1, Carry1, Carry2;

// First half adder (A and B)
assign Sum1 = A ^ B;     // First sum
assign Carry1 = A & B;   // First carry

// Second half adder (Sum1 and Cin)
assign Sum = Sum1 ^ Cin;  // Final sum
assign Carry2 = Sum1 & Cin;  // Second carry
```

```
// Final carry out
assign Cout = Carry1 | Carry2;

endmodule
```

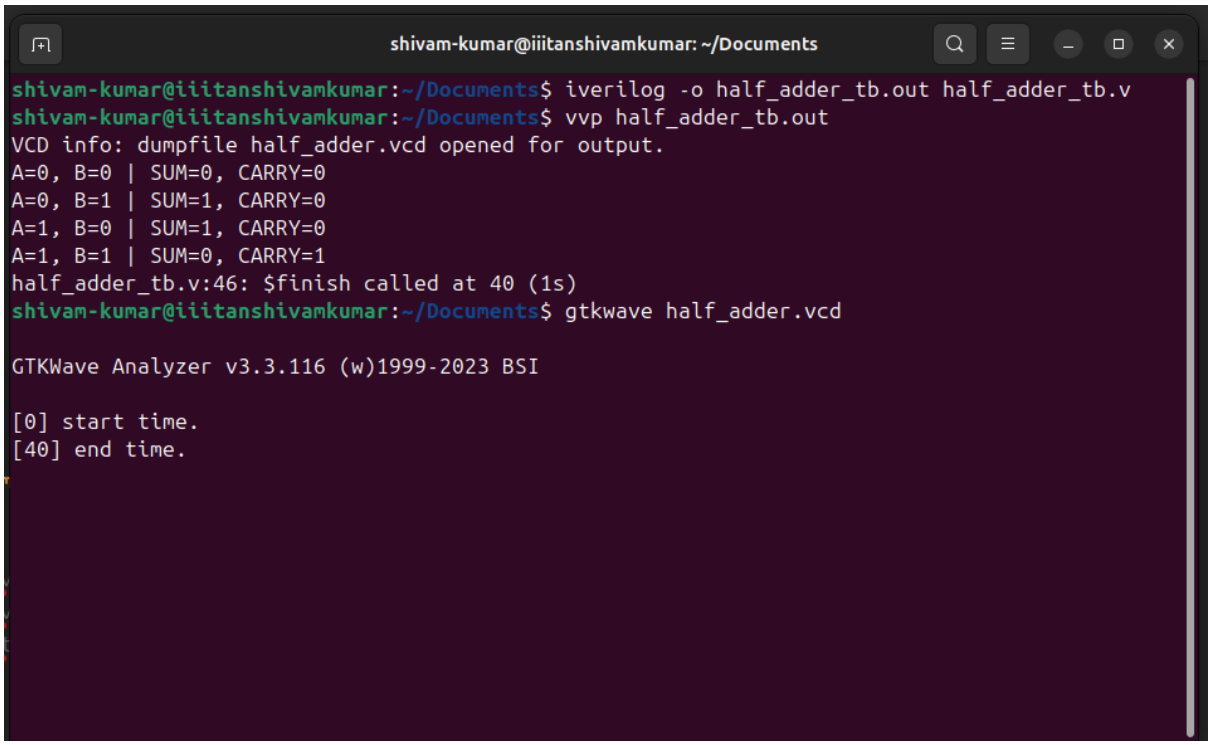
testbench:

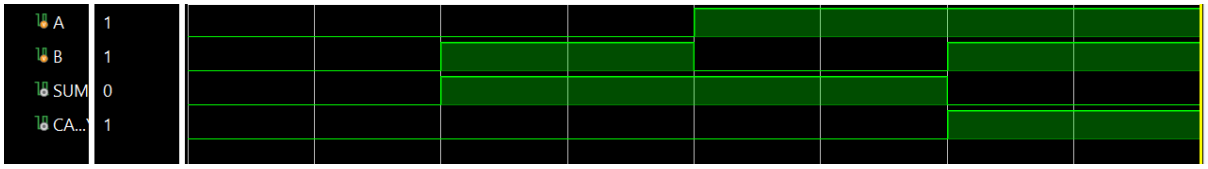
```
// Testbench for Full Adder
module tb_full_adder;

  reg A, B, Cin;  // Test inputs
  wire Sum, Cout; // Outputs from full adder

  // Instantiate the full adder
  full_adder uut (
    .A(A),
    .B(B),
    .Cin(Cin),
    .Sum(Sum),
    .Cout(Cout)
```

```
  );

  initial begin
    // Create a VCD file for GTKWave
    $dumpfile("full_adder_tb.vcd");
    $dumpvars(0, tb_full_adder);

    // Display the outputs
    $monitor("A=%b B=%b Cin=%b | Sum=%b Cout=%b",
A, B, Cin, Sum, Cout);

    // Test cases
    A = 0; B = 0; Cin = 0; #10;
    A = 0; B = 1; Cin = 0; #10;
    A = 1; B = 0; Cin = 0; #10;
    A = 1; B = 1; Cin = 0; #10;
    A = 0; B = 0; Cin = 1; #10;
    A = 0; B = 1; Cin = 1; #10;
    A = 1; B = 0; Cin = 1; #10;
    A = 1; B = 1; Cin = 1; #10;
```

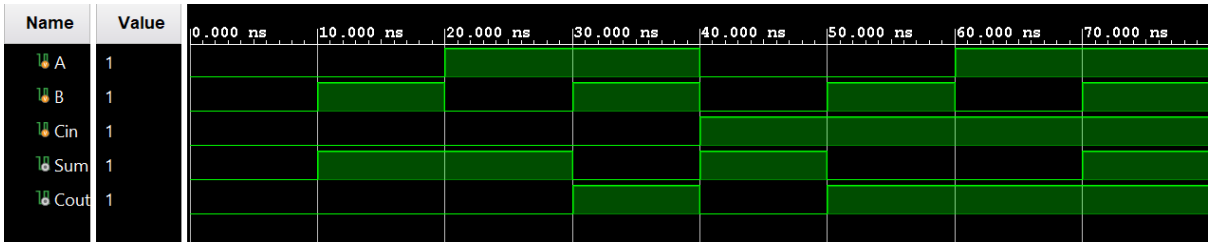
```
    // End the simulation
    $finish;
  end

endmodule
```

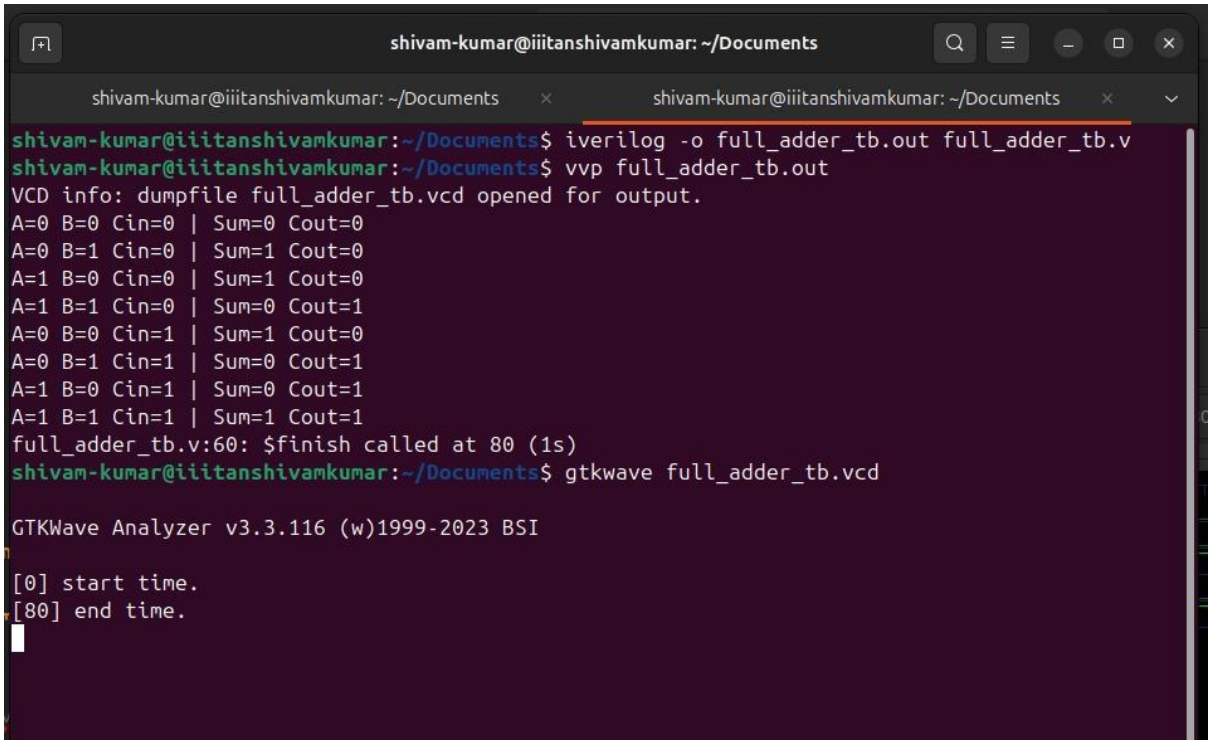
output : half adder





Full adder:




shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar: ~/Documents
shivam-kumar@iiitanshivamkumar:~/Documents$ iverilog -o full_adder_tb.out full_adder_tb.v
shivam-kumar@iiitanshivamkumar:~/Documents$ vvp full_adder_tb.out
VCD info: dumpfile full_adder_tb.vcd opened for output.
A=0 B=0 Cin=0 | Sum=0 Cout=0
A=0 B=1 Cin=0 | Sum=1 Cout=0
A=1 B=0 Cin=0 | Sum=1 Cout=0
A=1 B=1 Cin=0 | Sum=0 Cout=1
A=0 B=0 Cin=1 | Sum=1 Cout=0
A=0 B=1 Cin=1 | Sum=0 Cout=1
A=1 B=0 Cin=1 | Sum=0 Cout=1
A=1 B=1 Cin=1 | Sum=1 Cout=1
full_adder_tb.v:60: $finish called at 80 (1s)
shivam-kumar@iiitanshivamkumar:~/Documents$ gtkwave full_adder_tb.vcd
GTKWave Analyzer v3.3.116 (w)1999-2023 BSI
[0] start time.
[80] end time.

Lab 4

Main:

Demux:

```
`timescale 1ns / 1ps
//// File: demux_1to8.v
module demux_1to8 (
    input wire i,           // Input
    input wire [2:0] sel,   // 3-bit selection line
    output reg y0,          // Output 0
    output reg y1,
    output reg y2,
    output reg y3,
    output reg y4,
    output reg y5,
    output reg y6,
    output reg y7
);
    always @(*) begin
        y0 = 0;
        y1 = 0;
```

```
        y2 = 0;
        y3 = 0;
        y4 = 0;
        y5 = 0;
        y6 = 0;
        y7 = 0;

        case(sel)
            3'b000: y0 = i;
            3'b001: y1 = i;
            3'b010: y2 = i;
            3'b011: y3 = i;
            3'b100: y4 = i;
            3'b101: y5 = i;
            3'b110: y6 = i;
            3'b111: y7 = i;
            default: ;
        endcase
    end
endmodule
```

testbench:demux:

```
`timescale 1ns / 1ps
//// File: tb_demux_1to8.v
module tb_demux_1to8;
    reg i;
    reg [2:0] sel;
    wire y0, y1, y2, y3, y4, y5, y6, y7;

    // Instantiate the DEMUX
    demux_1to8 uut (
        .i(i),
        .sel(sel),
        .y0(y0), .y1(y1), .y2(y2), .y3(y3),
        .y4(y4), .y5(y5), .y6(y6), .y7(y7)
    );

    initial begin
        // Initialize input
        i = 1;
        sel = 3'b000; #10;
```

```
        sel = 3'b001; #10;
        sel = 3'b010; #10;
        sel = 3'b011; #10;
        sel = 3'b100; #10;
        sel = 3'b101; #10;
        sel = 3'b110; #10;
        sel = 3'b111; #10;
        $finish;
    end

    initial begin
        $monitor("sel=%b, y0=%b, y1=%b, y2=%b, y3=%b, y4=%b, y5=%b, y6=%b, y7=%b", sel, y0, y1, y2, y3, y4, y5, y6, y7);
    end
endmodule
```

Main:mux:

```
`timescale 1ns / 1ps
// File: mux_8to1.v
module mux_8to1 (
    input wire [2:0] sel,  // 3-bit selection line
    input wire i0,         // Input 0
    input wire i1,         // Input 1
    input wire i2,         // Input 2
    input wire i3,         // Input 3
    input wire i4,         // Input 4
    input wire i5,         // Input 5
    input wire i6,         // Input 6
    input wire i7,         // Input 7
    output reg y           // Output
);
    always @(*) begin
        case(sel)
            3'b000: y = i0;
            3'b001: y = i1;
            3'b010: y = i2;
```

```
            3'b011: y = i3;
            3'b100: y = i4;
            3'b101: y = i5;
            3'b110: y = i6;
            3'b111: y = i7;
            default: y = 1'bx;
        endcase
    end
endmodule
```

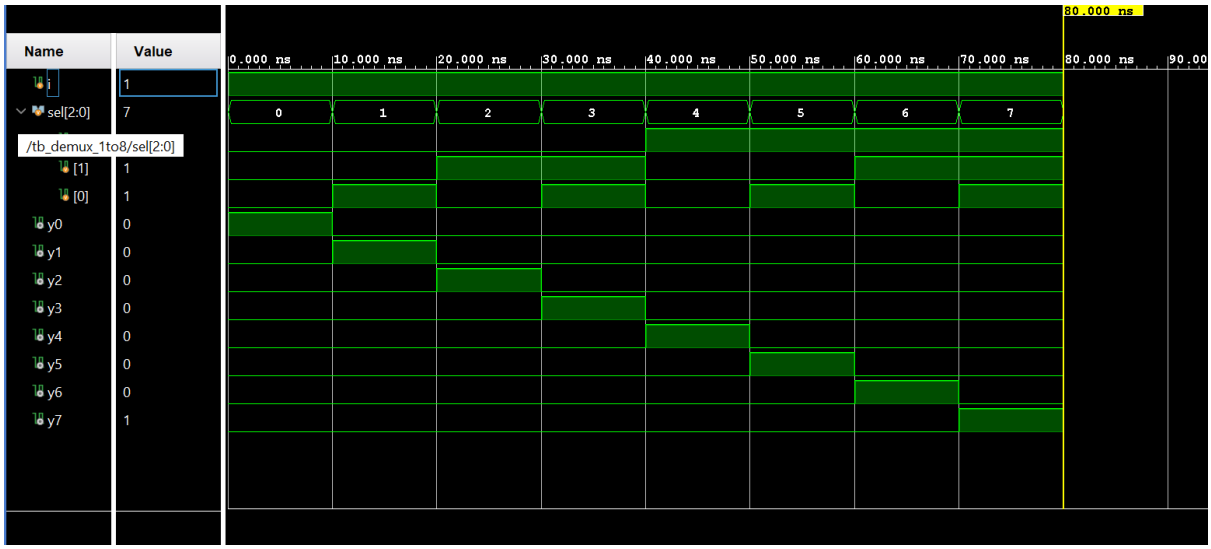
Testbench:mux:

```
`timescale 1ns / 1ps
/// File: tb_mux_8to1.v
module tb_mux_8to1;
    reg [2:0] sel;
    reg i0, i1, i2, i3, i4, i5, i6, i7;
    wire y;

    // Instantiate the MUX
    mux_8to1 uut (
        .sel(sel),
        .i0(i0), .i1(i1), .i2(i2), .i3(i3),
        .i4(i4), .i5(i5), .i6(i6), .i7(i7),
        .y(y)
    );

    initial begin
        // Initialize inputs
        {i0, i1, i2, i3, i4, i5, i6, i7} = 8'b10101011;
        sel = 3'b000; #10;
```

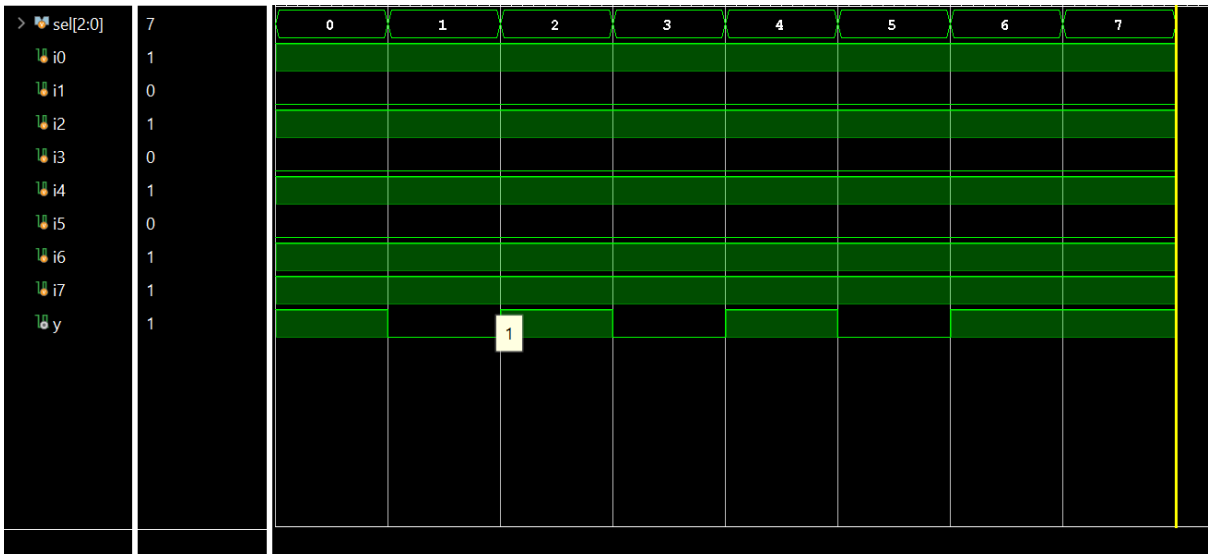
```
        sel = 3'b001; #10;
        sel = 3'b010; #10;
        sel = 3'b011; #10;
        sel = 3'b100; #10;
        sel = 3'b101; #10;
        sel = 3'b110; #10;
        sel = 3'b111; #10;
        $finish;
    end

    initial begin
        $monitor("sel=%b, y=%b", sel, y);
    end
endmodule
```

Results:

Demux:



MUX:



LAB 5:

Main:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 26.09.2024 15:18:17
// Design Name:
// Module Name: LAB5_NAND
// Project Name:
// Target Devices:
// Tool Versions:
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
```

```
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module LAB5_NAND(
    input A,
    input B,
    input C,
    output Y,
    output Z
    );
    wire a1,a2,a3,a4,a5,a6,a7,a8,a9;
    assign a1=~(A&B);   // nand one

    assign a2 =~(B&a1); //nand 2

    assign a3=~(A&a1) ;//nand 3
```

```
    assign a4 = ~(a2&a3); //nand 4

    assign a5 =~(a4&C); // nand 5

    assign a6=~(a4&a5) ;//nand 6

    assign a7=~(a5&a1);// nand 7 -> output ->Z

    assign a8=~(C&a5);// nand 8;

    assign a9=~(a6&a8);  // nand 9 ->output->Y

    //assigning value to outputs
    assign Z=a7;

    assign Y=a9;


endmodule
```

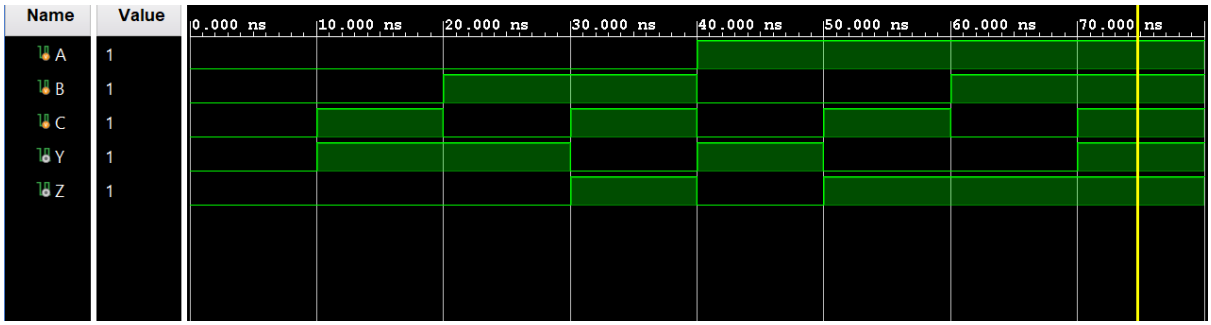
testbench:

```
`timescale 1ns / 1ps
////////////////////////////////////////////////////////////////////////////////
// Testbench for LAB5_NAND
////////////////////////////////////////////////////////////////////////////////

module LAB5_NAND_tb();

    // Inputs
    reg A;
    reg B;
    reg C;

    // Outputs
    wire Y,Z;



    // Instantiate the Unit Under Test (UUT)
    LAB5_NAND uut(A,B,C,Y,Z);
```

```
initial begin

    A = 0; B = 0; C = 0;// Test case 1
    #10;


    A = 0; B = 0; C = 1; // Test case 2
    #10;


    A = 0; B = 1; C = 0;    // Test case 3
    #10;


    A = 0; B = 1; C = 1;  // Test case 4
    #10;
```

```
        A = 1; B = 0; C = 0; // Test case 5
        #10;


        A = 1; B = 0; C = 1; // Test case 6
        #10;


        A = 1; B = 1; C = 0;  // Test case 7
        #10;

        A = 1; B = 1; C = 1;// Test case 8
        #10;

        // Finish simulation
        $finish;
    end

endmodule
```

results:


Name
Value
0.000 ns
10.000 ns
20.000 ns
30.000 ns
40.000 ns
50.000 ns
60.000 ns
70.000 ns
A
1
B
1
C
1
Y
1
Z
1

LAB_6

Main:

LAB 7:

Main:ring counter

```
module RingCounter(
    input clk,
    input reset,
    output reg [3:0] q
);
    always @(posedge clk or posedge reset) begin
        if (reset)
            q <= 4'b0001; // Reset to initial state
        else
            q <= {q[2:0], q[3]}; // Shift left and wrap around
    end
endmodule
```

testbench:ring counter

```
`timescale 1ns / 1ps
```

```
module ring_counter_tb;
    reg clk;
    reg reset;
    wire [3:0] q;

    // Instantiate the RingCounter module
    ring_counter uut (
        .clk(clk),
        .reset(reset),
        .q(q)
    );

    // Clock generation
    initial begin
        clk = 0;
        forever #5 clk = ~clk; // Generate a clock with a
period of 10 ns
    end

    // Test sequence
```

```
    initial begin
        // Initialize simulation
        $display("Starting simulation...");

        // Apply reset
        reset = 1;
        #10; // Hold reset high for 10 ns
        $display("Time: %0t, Reset applied, Q: %b", $time,
q);

        // Release reset and observe ring counter
        reset = 0;
        #50; // Run simulation for 50 ns
        $display("Time: %0t, Reset released, Q after 50 ns:
%b", $time, q);

        // Apply reset again to verify reset functionality
        reset = 1;
        #10;
        $display("Time: %0t, Reset applied again, Q: %b",
$time, q);
```

```
        reset = 0;
        #30;
        $display("Time: %0t, Final Q after additional 30 ns:
%b", $time, q);

        // End simulation
        $display("Ending simulation...");
        $stop;
    end
endmodule
main:
sync:counter
module sync_counter(
    input clk,
    input reset,
    output reg [1:0] q
);
    always @(posedge clk or posedge reset) begin
        if (reset)
```

```
            q <= 2'b00; // Reset to 0
        else
            q <= q + 1; // Increment counter
    end
endmodule
```

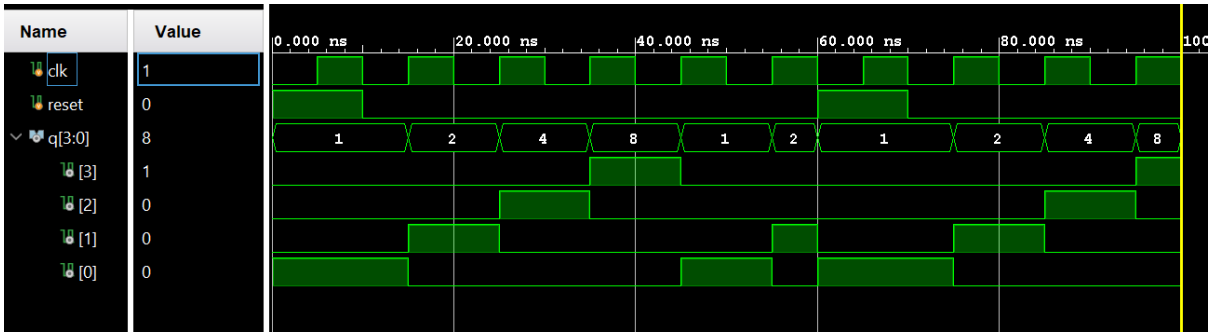
testbench:

```
module tb_SyncCounter;
    reg clk;
    reg reset;
    wire [1:0] q;
    // Instantiate the SyncCounter module
    SyncCounter uut (
        .clk(clk),
        .reset(reset),
        .q(q)
    );
    // Clock generation
    initial begin
        clk = 0;
        forever #5 clk = ~clk; // 10 time units period
```

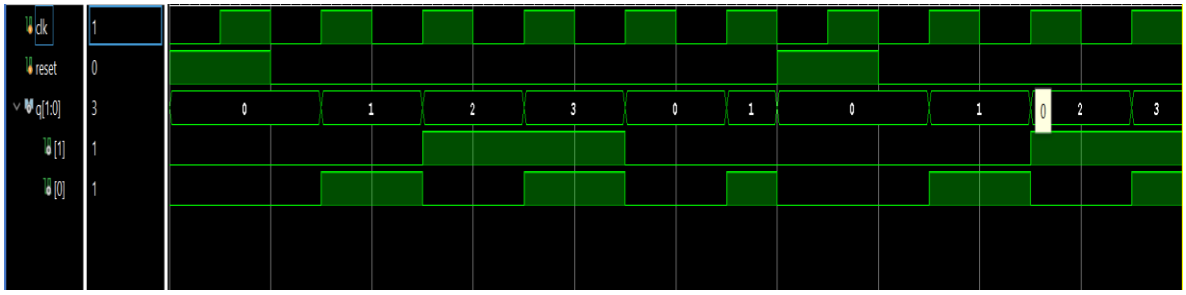
```
    end
    // Test sequence
    initial begin
        $monitor($time, " Reset=%b, Q=%b", reset, q);
        reset = 1; #10; // Apply reset
        reset = 0; #50; // Run for a few cycles
        reset = 1; #10; // Apply reset again
        reset = 0; #30; // Run for a few more cycles
        $stop;
    end
endmodule
```

output:

ring counter



Sync counter


clk
reset
q[1:0]
[1]
[0]
1
0
3
1
1
0
1
2
3
0
1
0
1
0
2
3

LAB 8:

Main:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 07.11.2024 15:58:05
// Design Name: ALU
// Module Name: ALU
// Project Name:
// Target Devices:
// Tool Versions:
```

```
// Description: 4-bit ALU with 16 operations
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module ALU(
    input wire [3:0] A,
    input wire [3:0] B,
    input wire [3:0] S,
    output reg [3:0] x
);

    always @(*) begin
```

```
case (S)
    4'b0000: x = A;

    4'b0001: x = ~A;

    4'b0010: x = A | B;

    4'b0011: x = A & B;

    4'b0100: x = A ^ B;

    4'b0101: x = ~(A | B);

    4'b0110: x = ~(A & B);

    4'b0111: x = ~(A ^ B);

    4'b1000: x = A + B;

    4'b1001: x = A - B;
```

```
        4'b1010: x = A * B;

        4'b1011: x = (B != 0) ? (A / B) : 4'b0000;

        4'b1100: x = (A > B) ? 4'b0001 : 4'b0000;

        4'b1101: x = A ** B;

        4'b1110: x = A >> B;

        4'b1111: x = A << B;

        default: x = 4'b0000;
      endcase
   end

endmodule
```

Test bench:

```
`timescale 1ns / 1ps
//////////////////////////////////////////////////////////////////////////////////
// Company:
// Engineer:
//
// Create Date: 07.11.2024
// Design Name: ALU Testbench
// Module Name: ALU_tb
// Project Name:
// Target Devices:
// Tool Versions:
// Description: Testbench for 4-bit ALU with 16 operations
//
```

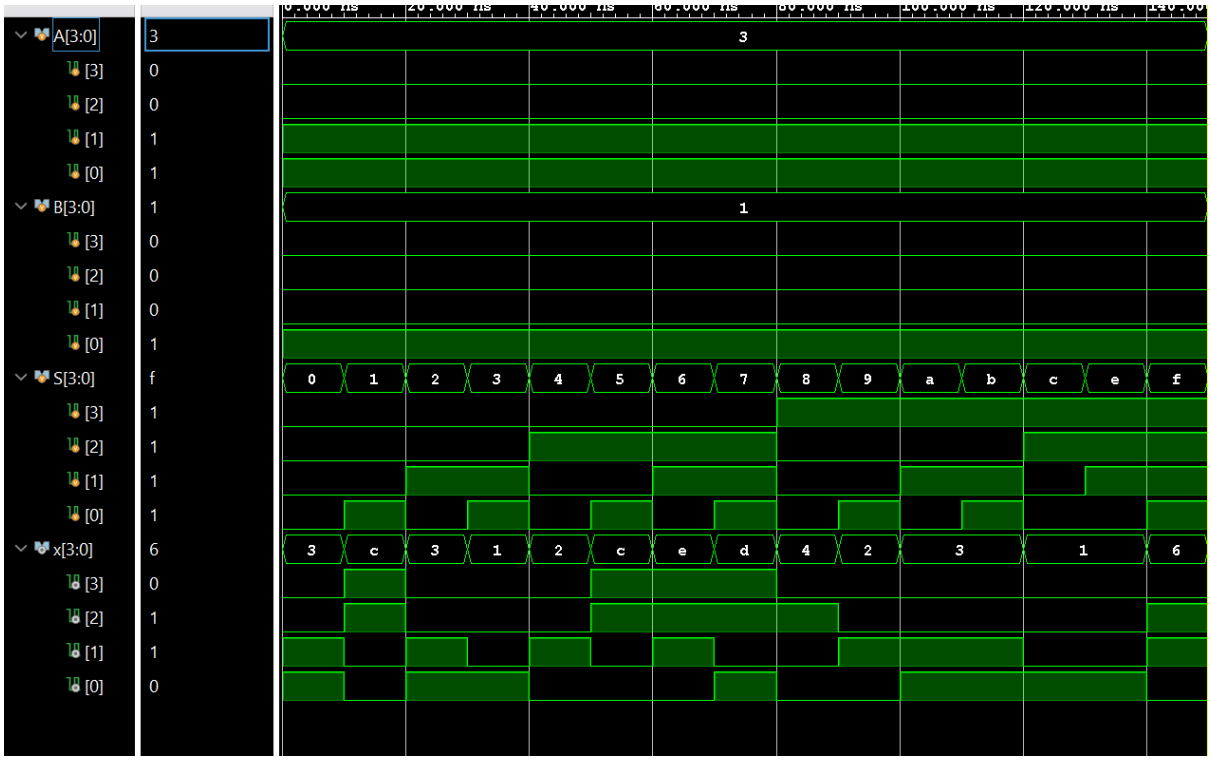
```
//////////////////////////////////////////////////////////////////////////
```

```
module ALU_tb;
    // Testbench registers and wires
    reg [3:0] A;
    reg [3:0] B;
    reg [3:0] S;
    wire [3:0] x;


    ALU uut (
        .A(A),
        .B(B),
        .S(S),
        .x(x)
    );


    initial begin
```

```
A = 4'b0011; B = 4'b0001;



S = 4'b0000; #10;
S = 4'b0001; #10;
S = 4'b0010; #10;
S = 4'b0011; #10;
S = 4'b0100; #10;
S = 4'b0101; #10;
S = 4'b0110; #10;
S = 4'b0111; #10;
S = 4'b1000; #10;
S = 4'b1001; #10;
S = 4'b1010; #10;
S = 4'b1011; #10;
S = 4'b1100; #10;
S = 4'b1110; #10;
S = 4'b1111; #10;
```

```
    $finish;
  end
endmodule
```

output:



Lab 9:

Main:

```
module cyclic_lamp(clock, light);
   input clock;
   output reg [2:0] light; //light is a vector
   parameter s0=2'b00, s1=2'b01, s2=2'b10; //
parameter declaration as constant \
   parameter RED=3'b100, GREEN=3'b010,
YELLOW=3'b001;
   reg[1:0] state=s0; //state as two bit variable
   reg[27:0] count=0;
   reg clock_out;


//    always@( posedge clock )
//      begin
//        count<=count+1;
```

```
//        if (count==100000000)
//            begin count<=0;
//                clock_out=~clock_out;
//            end
//     end

    initial begin
        state = s0;
        light = RED;
        clock_out = 0;
    end

    always@(posedge clock )
        case (state)
        s0: state<=s1;
        s1: state<=s2;
        s2: state<=s0;
        default: state<=s0;
        endcase
```

```
    always@(state)
        case(state)
        s0: light=RED;
        s1: light=GREEN;
        s2: light=YELLOW;
        default light=RED;
        endcase
endmodule
```

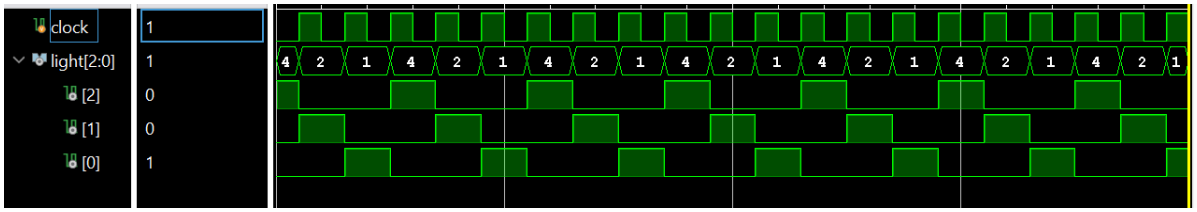
Testbench:

```
`timescale 1ns / 1ps

module tb_cyclic_lamp;

// Inputs
reg clock;

// Outputs
wire [2:0] light;

// Instantiate the Unit Under Test (UUT)
cyclic_lamp uut (
    .clock(clock),
```

```
    .light(light)
);

// Clock generation
initial begin
    clock = 0;
    forever #5 clock = ~clock; // Generate a clock signal with a period of 10 ns
end

// Testbench process
initial begin
    // Display header
    $display("Time\tClock\tLight");

    // Monitor the changes in outputs
    $monitor("%4d\t%b\t%b", $time, clock, light);

    // Simulation run for 100 clock cycles
    #1000;
```

```
    $finish;
end


endmodule
```

Result:



LAB 10:

Main:

Ocla:

`timescale 1ns / 1ps

//

// Company:

// Engineer:

//

// Create Date: 21.11.2024 15:43:15

// Design Name:

// Module Name: OCLA

// Project Name:

// Target Devices:

// Tool Versions:

```
// Description:
//
// Dependencies:
//
// Revision:
// Revision 0.01 - File Created
// Additional Comments:
//
//////////////////////////////////////////////////////////////////////////////////


module OCLA (
    input [3:0] A,
    input [3:0] B,
    input Cin,
    output [3:0] Sum,
    output Cout
);
    wire [3:0] G, P, C;
    assign G = A & B;          // Generate
```

```
    assign P = A ^ B;          // Propagate
    assign C[0] = Cin;
    assign C[1] = G[0] | (P[0] & Cin );
    assign C[2] = G[1] | (P[1] & G[0]) | (P[1]&P[0]&Cin);
    assign C[3] = G[2] | (P[2] & G[1]) | (P[2]&P[1]&G[0])
| (P[2]&P[1]&P[0]&Cin);
    assign Cout = G[3] | (P[3] & G[2]) | (P[3] & G[2] &
P[2]) | (P[3]&P[2]&P[1]&G[0]) |
(P[3]&P[2]&P[1]&P[0]&Cin);
    assign Sum = P ^ C;
endmodule
```

Testbench;

```
`timescale 1ns/1ps

module OCLA_tb;
    // Testbench signals
    reg [3:0] A, B;
    reg Cin;
    wire [3:0] Sum;
    wire Cout;

    // Instantiate the CLA module
    OCLA cla_inst (
        .A(A),
        .B(B),
```

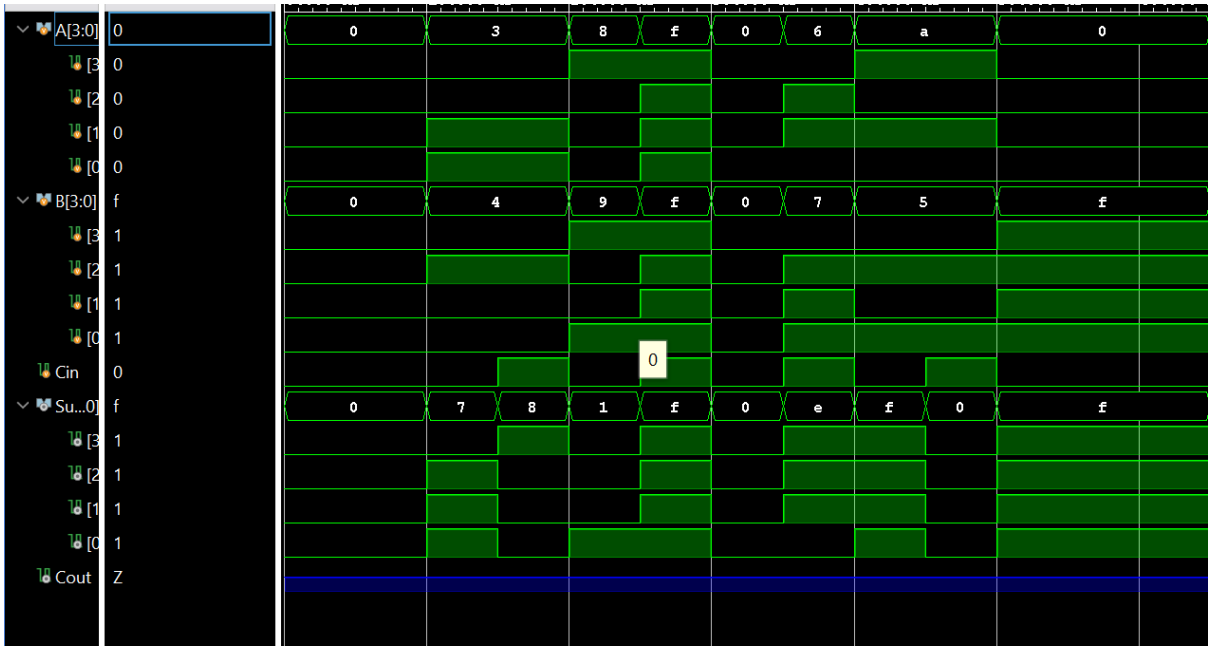
```
        .Cin(Cin),
        .Sum(Sum),
        .Cout(Cout)
    );

    // Helper task to display test results
    task display_test;
        input [3:0] exp_sum;
        input exp_cout;
        begin
            #5;  // Wait for combinational logic to settle
            if ({Cout, Sum} === {exp_cout, exp_sum}) begin
                $display("PASS: A=%h, B=%h, Cin=%b | Sum=%h, Cout=%b", A, B, Cin, Sum, Cout);
            end else begin
                $display("FAIL: A=%h, B=%h, Cin=%b | Expected: Sum=%h, Cout=%b | Got: Sum=%h, Cout=%b",
                         A, B, Cin, exp_sum, exp_cout, Sum, Cout);
            end
```

```
    end
endtask

// Test stimulus
initial begin
    // Initialize inputs
    A = 0; B = 0; Cin = 0;
    #10;

    // Test Case 1: Basic addition without carry
    A = 4'h3; B = 4'h4; Cin = 0;
    display_test(4'h7, 0);

    // Test Case 2: Addition with input carry
    A = 4'h3; B = 4'h4; Cin = 1;
    display_test(4'h8, 0);

    // Test Case 3: Addition causing output carry
    A = 4'h8; B = 4'h9; Cin = 0;
    display_test(4'h1, 1);
```

```
// Test Case 4: Maximum value test
A = 4'hF; B = 4'hF; Cin = 1;
display_test(4'hF, 1);

// Test Case 5: Zero value test
A = 4'h0; B = 4'h0; Cin = 0;
display_test(4'h0, 0);

// Test Case 6: Random test cases
A = 4'h6; B = 4'h7; Cin = 1;
display_test(4'hE, 0);

A = 4'hA; B = 4'h5; Cin = 0;
display_test(4'hF, 0);

// Test Case 7: Alternating bits
A = 4'hA; B = 4'h5; Cin = 1;
display_test(4'h0, 1);
```

```
        // Test Case 8: One operand zero
        A = 4'h0; B = 4'hF; Cin = 0;
        display_test(4'hF, 0);

        // End simulation
        #10;
        $display("Simulation completed");
        $finish;
    end

    // Optional: Generate VCD file for waveform viewing
    initial begin
        $dumpfile("cla_test.vcd");
        $dumpvars(0, OCLA_tb);
    end

endmodule
```

Output:


A[3:0]
0
[3
0
[2
0
[1
0
[0
0
B[3:0]
f
[3
1
[2
1
[1
1
[0
1
Cin
0
Su...0]
f
[3
1
[2
1
[1
1
[0
1
Cout
Z
0
3
8
f
0
6
a
0
0
4
9
f
0
7
5
f
0
0
7
8
1
f
0
e
f
0
f