EAST WEST UNIVERSITY

PROJECT REPORT

Course Title: Digital Logic Design

Course Code: CSE345

Sec: 08

Submitted to:

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Submitted by:

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Submission Date:

21st Jan, 2025

I. Introduction

- **Project Title:** BCD to Decimal Converter

- *Authors:*

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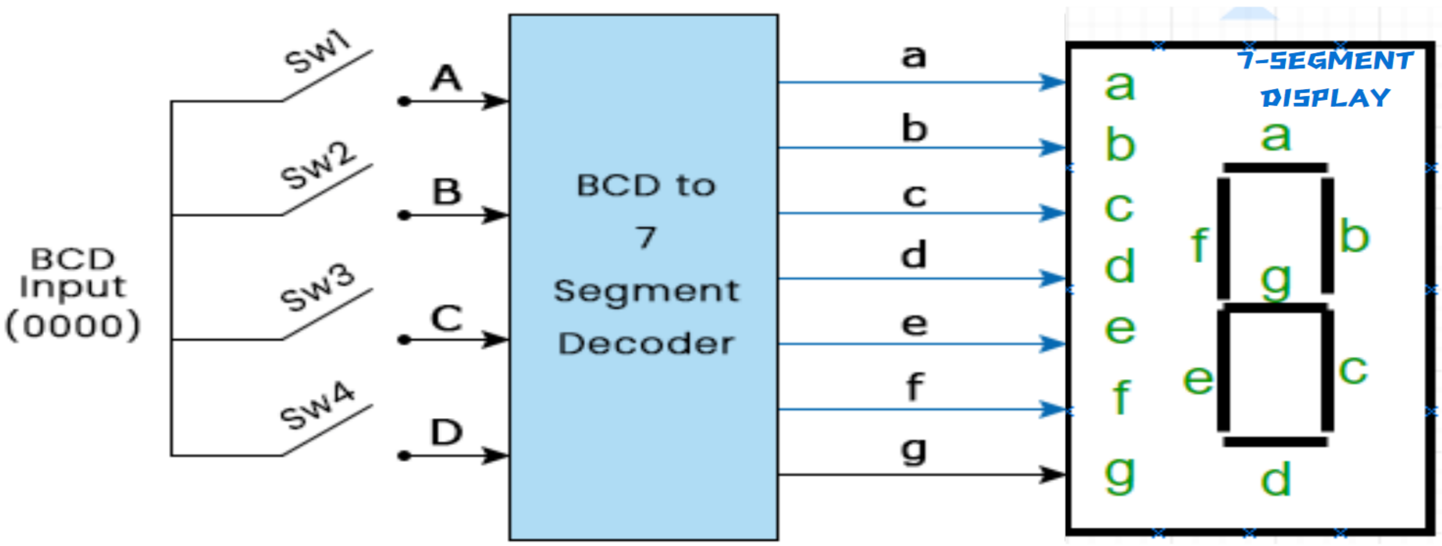
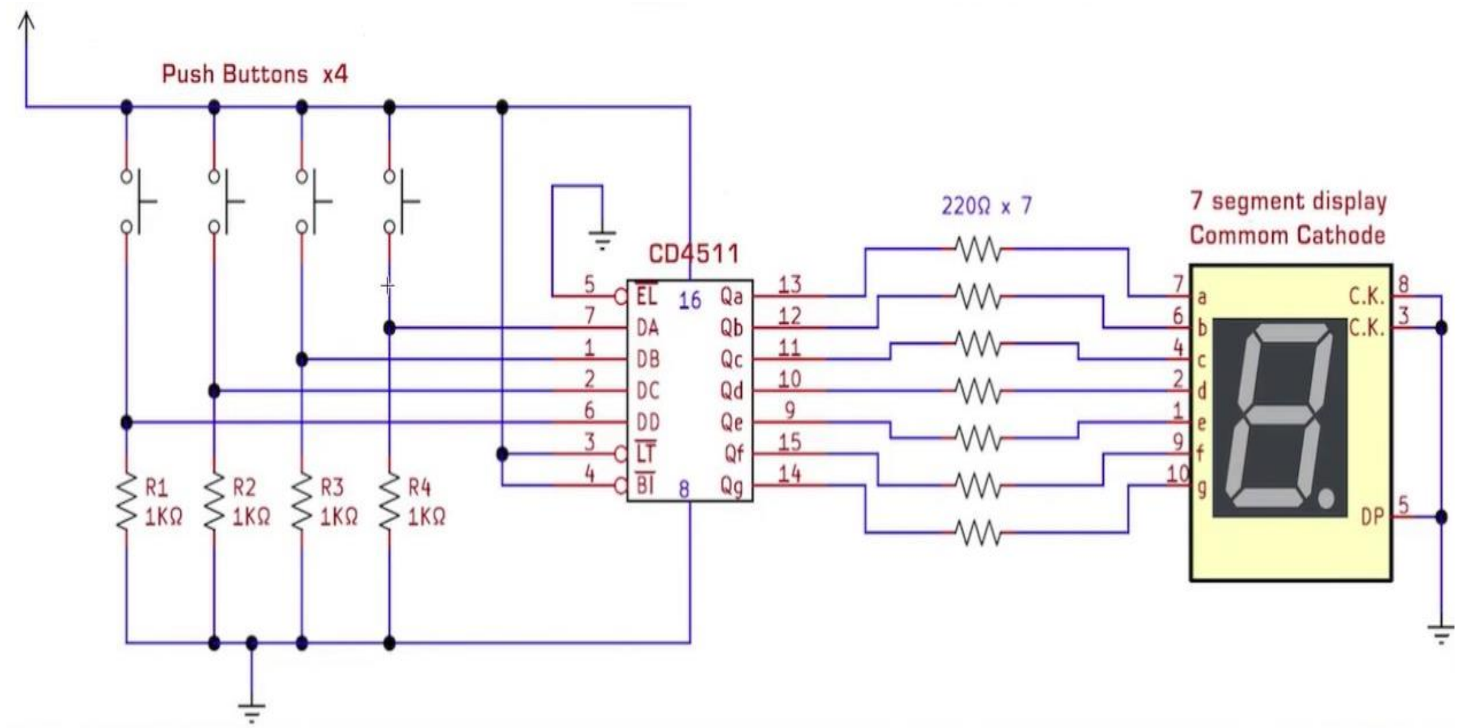
Abstract:

The Binary-Coded Decimal (BCD) system represents decimal numbers using binary digits. Each decimal digit (0-9) is represented by a 4-bit binary code. A BCD to Decimal Converter translates these binary codes into a decimal form that can be displayed on devices like seven-segment displays.

This project focuses on designing a BCD to Decimal Converter circuit using basic logic gates and connecting it to a common cathode seven-segment display to visually display the decimal output.

II. Block Diagram





III. Project Description

To understand fundamental digital electronics principles and their real-world applications. Developing a BCD to Decimal Converter allows students and hobbyists to explore the interaction between logic gates, binary systems, and practical display mechanisms. This project serves as an educational tool for understanding combinational logic design and its significance in modern electronics.

- **Scope**:

1. This project serves as a practical demonstration of combinational logic circuits.
2. It can be used in educational settings to teach the fundamentals of digital electronics and BCD systems.
3. The circuit can be integrated into larger systems, such as calculators, digital clocks, and embedded devices requiring decimal displays.
4. It provides a foundation for more complex systems like hexadecimal or alphanumeric converters.

1. Truth Table

Decimal Digit	Input lines				Output lines							Display pattern
	A	B	C	D	a	b	c	d	e	f	g	
0	0	0	0	0	1	1	1	1	1	1	0	0
1	0	0	0	1	0	1	1	0	0	0	0	1
2	0	0	1	0	1	1	0	1	1	0	1	2
3	0	0	1	1	1	1	1	1	0	0	1	3
4	0	1	0	0	0	1	1	0	0	1	1	4
5	0	1	0	1	1	0	1	1	0	1	1	5
6	0	1	1	0	1	0	1	1	1	1	1	6
7	0	1	1	1	1	1	1	0	0	0	0	7
8	1	0	0	0	1	1	1	1	1	1	1	8
9	1	0	0	1	1	1	1	1	0	1	1	9

From the above truth table, the 7 Segment Display Boolean expression of each output functions can be written as:

a = F1 (A, B, C, D) = **∑m (0, 2, 3, 5, 7, 8, 9)**

b = F2 (A, B, C, D) = **∑m (0, 1, 2, 3, 4, 7, 8, 9)**

c = F3 (A, B, C, D) = **∑m (0, 1, 3, 4, 5, 6, 7, 8, 9)**

d = F4 (A, B, C, D) = **∑m (0, 2, 3, 5, 6, 8)**

e = F5 (A, B, C, D) = **∑m (0, 2, 6, 8)**

f = F6 (A, B, C, D) = **∑m (0, 4, 5, 6, 8, 9)**

g = F7 (A, B, C, D) = **∑m (2, 3, 4, 5, 6, 8, 9)**

2. K-Map & Simplified Equations

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	1	1	1
11	×	×	×	×
10	1	1	×	×

$a = A + C + BD + \overline{B}\,\overline{D}$

AB \ CD	00	01	11	10
00	1	0	1	1
01	1	0	1	0
11	×	×	×	×
10	1	1	×	×

$b = \overline{B} + \overline{C}\,\overline{D} + CD$

AB \ CD	00	01	11	10
00	1	1	1	0
01	1	1	1	1
11	×	×	×	×
10	1	1	×	×

$c = B + \overline{C} + D$

AB \ CD	00	01	11	10
00	1	0	1	1
01	0	1	0	1
11	×	×	×	×
10	1	1	×	×

$d = \overline{B}\,\overline{D} + C\overline{D} + B\overline{C}D + \overline{B}C + A$

AB \ CD	00	01	11	10
00	1	0	0	1
01	0	0	0	1
11	×	×	×	×
10	1	0	×	×

$e = \overline{B}\,\overline{D} + C\overline{D}$

AB \ CD	00	01	11	10
00	1	0	0	0
01	1	1	0	1
11	×	×	×	×
10	1	1	×	×

$f = A + \overline{C}\,\overline{D} + B\overline{C} + B\overline{D}$

Display output Equations:

AB \ CD	00	01	11	10
00	0	0	1	1
01	1	1	0	1
11	×	×	×	×
10	1	1	×	×

$g = \overline{B}C + C\overline{D} + B\overline{C} + B\overline{C} + A$

$a = A + CD + B \odot D$

$b = \overline{B} + C \odot D$

$c = \overline{C} + B + D$

$d = \overline{B}\,\overline{D} + \overline{B}C + B\overline{C}D + C\overline{D}$

$e = \overline{B}\,\overline{D} + C\overline{D}$

$f = A + \overline{C}\,\overline{D} + B\overline{D} + B\overline{C}$

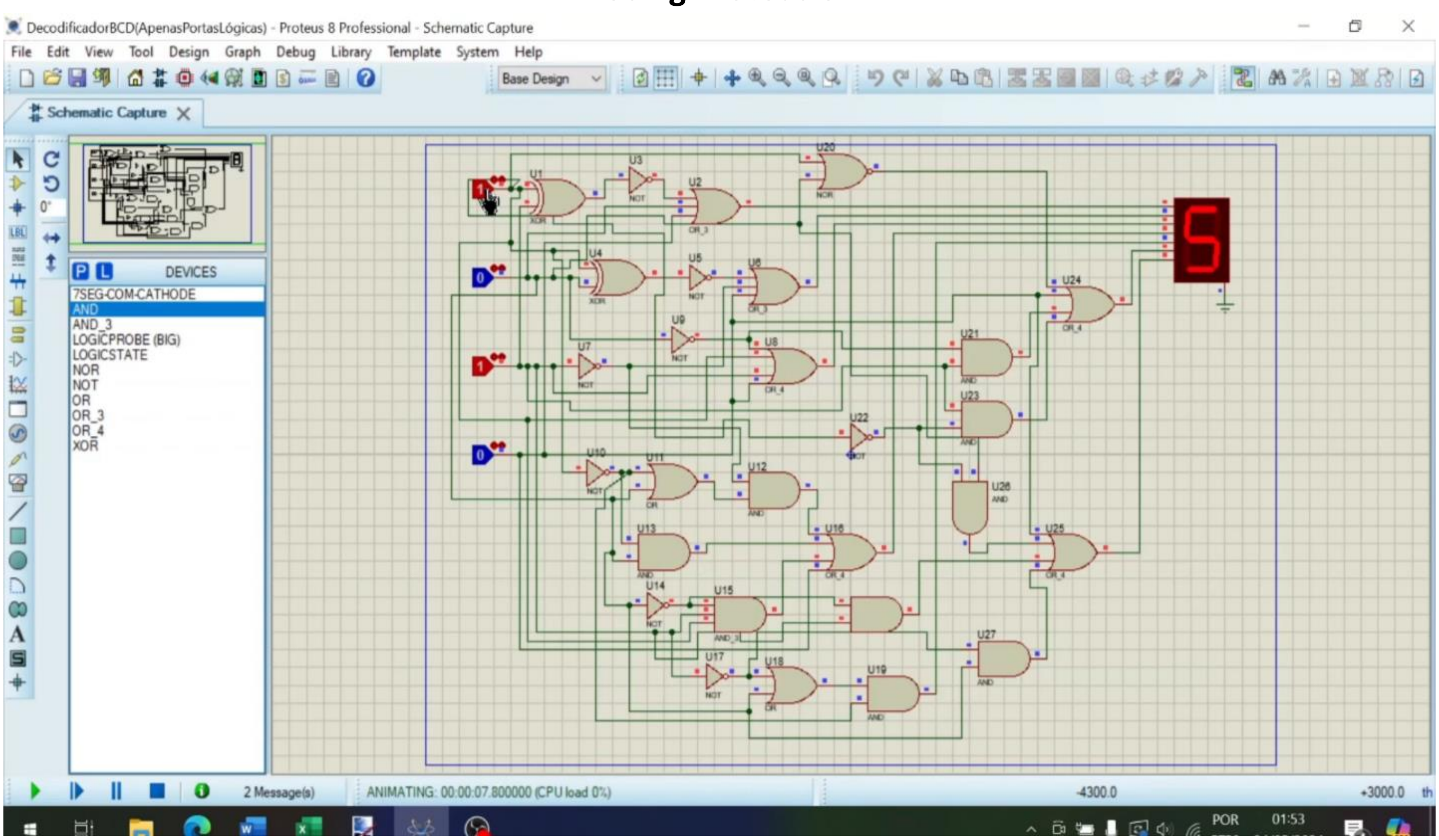
$g = A + B \oplus C + C\overline{D}$

Components

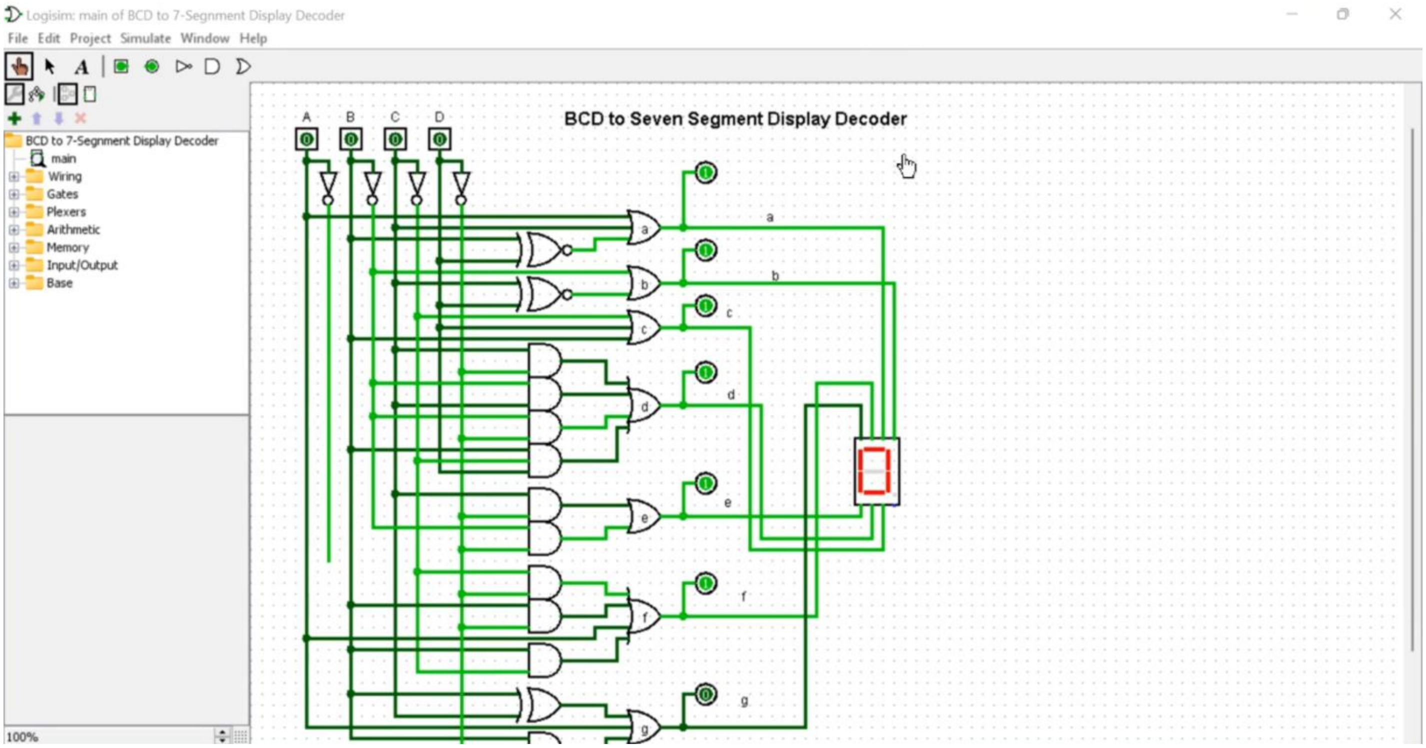
- ✓ 11 x 220 ohm
- ✓ 4 x 1k ohm resistor
- ✓ 1 x IC7404
- ✓ 3 x IC7408
- ✓ 4 x IC7432
- ✓ 1 x IC7486
- ✓ 4 x Full size breadboard
- ✓ 1 x RCCH101 common cathode 7-segment display
- ✓ 1 x 5V battery with clipper
- ✓ 4 x 5mm Red LED Lights
- ✓ 4 x Six-pins 8x8 mm self-locking DPDT push-pull switch
- ✓ Silver/copper connecting and jumping wires

3. Circuit Diagram (on Simulator)

Using Proteus 8



IV. Methodology



Using Logisim Simulation_5

Explanation:

1. The circuit takes **4 inputs** (A, B, C, D), representing a BCD code.

   - Each input is either HIGH (1) or LOW (0).
   - The BCD codes (0000 to 1001) represent decimal digits (0-9).

Step 2: Logic Circuit Design

1. The **logic gates** (AND, OR, NOT,XOR) process the inputs to generate signals for seven outputs (**a, b, c, d, e, f, g**).
2. Each output corresponds to one of the segments in the seven-segment display.

   Example:

- To display the digit **0**, segments **a, b, c, d, e, f** light up.

- The logic circuit ensures these segments are activated for the input 0000.

Step 3: Truth Table Reference

1. The **truth table** links the BCD inputs to the active segments.
2. For example:

    - Input 0101 (BCD for 5) activates segments **a, f, g, c, d**.

Step 4: Seven-Segment Display

1. The **common cathode** configuration means the cathode (negative terminal) is shared and connected to ground.
2. When an output (a-g) is HIGH (1), current flows through the respective LED segment, lighting it up.

Step 5: Resistors and Pull-Downs

1. **220 Ω resistors**:

    - Limit current to the LEDs in the display, preventing damage.

2. **1 kΩ pull-down resistors**:
    - Ensure input pins (A, B, C, D) default to LOW (0) when no voltage is applied.

Step 6: Invalid Input Handling

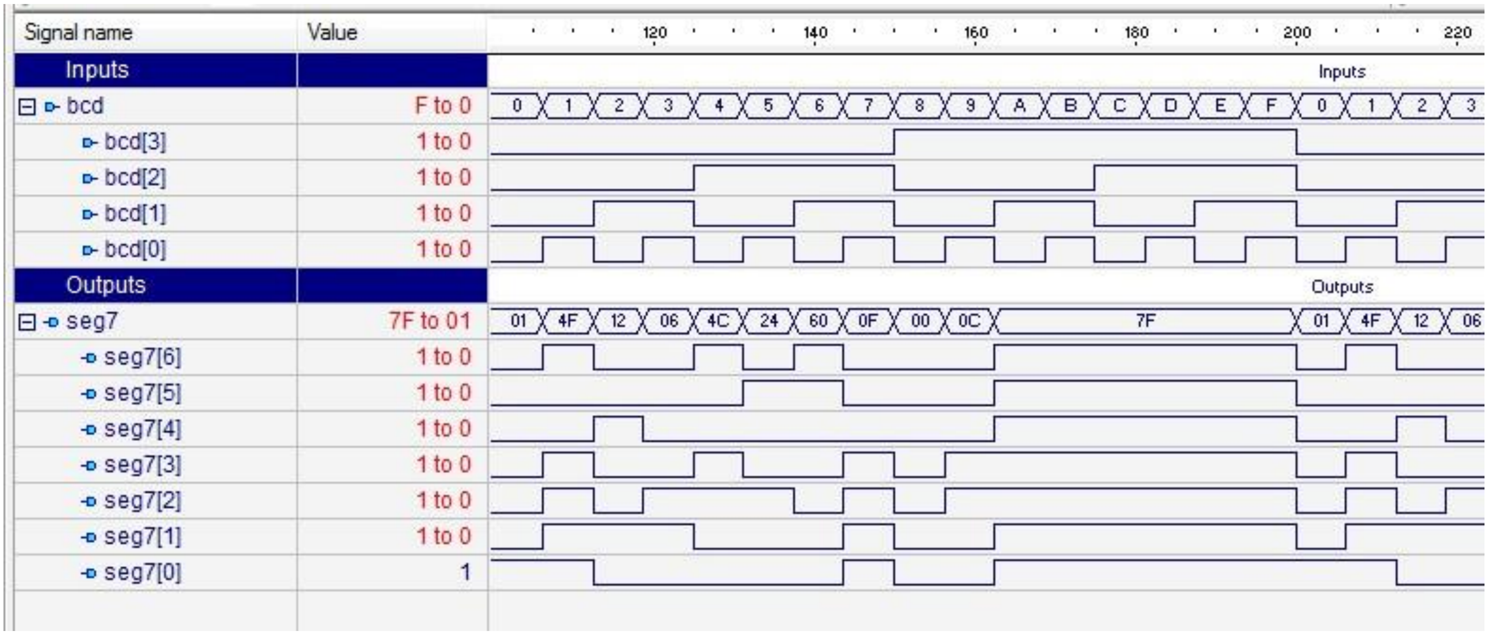
1. Inputs from 1010 to 1111 are ignored.
2. The logic circuit does not activate any segments for these inputs, leaving the display OFF.

Step 7: Power Supply

1. A stable **+5V DC power supply** powers the circuit.
2. All ICs and components are designed for this voltage.

V. Output Waveform (Simulator)

Behavior Modeling Style:



Output Waveform : BCD to 7 Segment Driver for common anode display

Verilog CODE -

```
//-----------------------------------------------------------------------------
// Title       : BCD_to_7seg
// Design      : verilog upload 2
// Author      : Abrar Khatib Lajim
//-----------------------------------------------------------------------------
//
// File        : BCD to 7 Segment Driver for common anode display using if else.v

module BCD_to_7seg ( bcd ,seg7 );

output [6:0] seg7 ;
reg [6:0] seg7 ;
input [3:0] bcd ;
wire [3:0] bcd ;
```

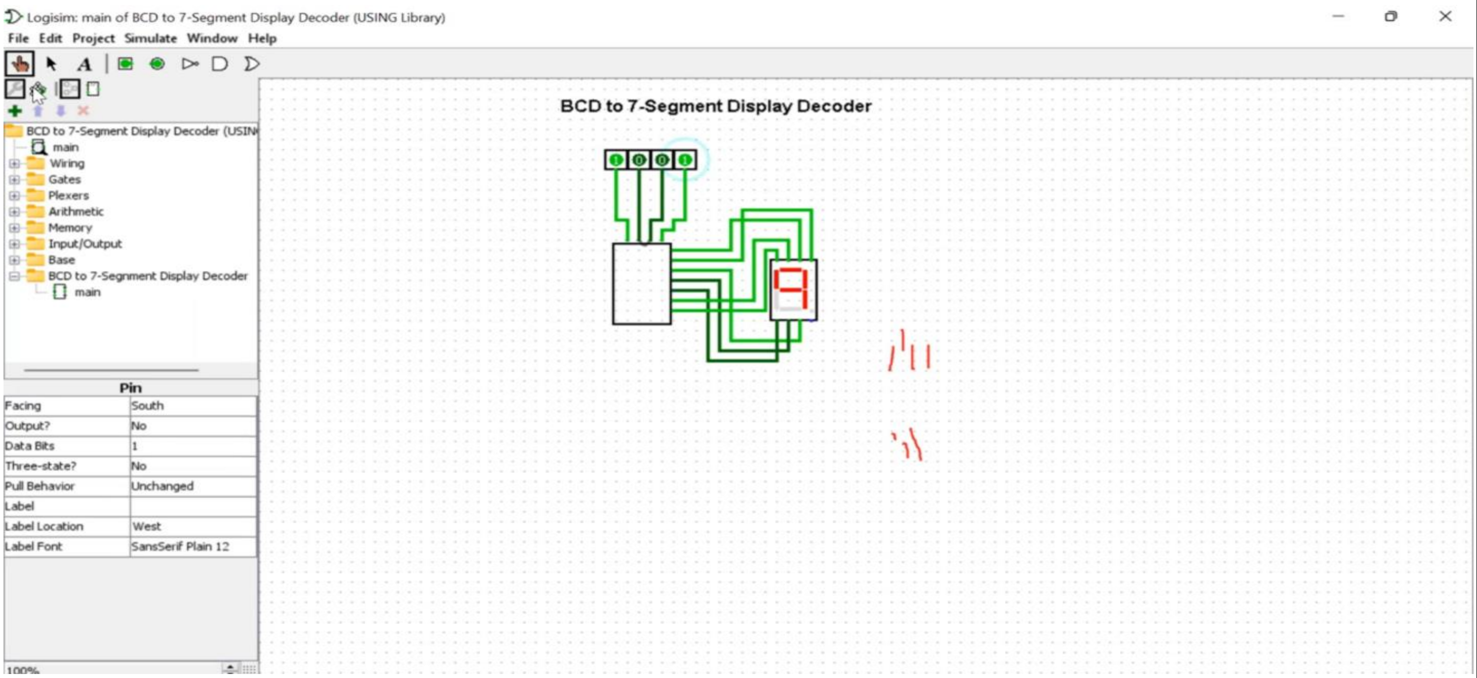
```
always @ (bcd) begin
if (bcd==0)
seg7 = 7'b0000001;
else if (bcd==1)
seg7 = 7'b1001111;
else if (bcd==2)
seg7 = 7'b0010010;
else if (bcd==3)
seg7 = 7'b0000110;
else if (bcd==4)
seg7 = 7'b1001100;
else if (bcd==5)
seg7 = 7'b0100100;
else if (bcd==6)
seg7 = 7'b1100000;
else if (bcd==7)
seg7 = 7'b0001111;
else if (bcd==8)
seg7 = 7'b0000000;
else if (bcd==9)
seg7 = 7'b0001100;
else
seg7 = 7'b1111111;
end
endmodule
```

VI. Output Through LED

Practical Implementation:

To verify the circuit's functionality, the outputs were connected to a common cathode seven-segment display. The LED illumination of each segment (a-g) represented the corresponding decimal digit for the given BCD input. For instance:

- **Input 0000**: Segments a, b, c, d, e, and f illuminated to display "0."
- **Input 1001**: Segments a, b, c, d, f, and g illuminated to display "9."



Observations:

- The observed practical results matched the expected outputs from the simulation.
- Differences in brightness among segments were minimized by using equal-value resistors.

Comparison with Simulations:

- Simulation outputs from tools such as Logisim were consistent with practical results.
- Minor deviations, such as segment flickering, were attributed to loose connections on the breadboard.

VII. Discussion

Project Objectives:

The project successfully met its objectives by:

- ✓ Accurately converting 4-bit BCD inputs into corresponding decimal outputs.
- ✓ Displaying the results on a seven-segment display.

Deviations:

- **Simulated vs Practical Results**:
    - ❖ Simulated results were perfect; practical implementation faced minor issues such as:
        - Slight variations in LED brightness.
        - Occasional loose connections in the breadboard setup.
    - ❖ These deviations were resolved by rechecking connections and using a soldered PCB for stability.

Analysis:

The results demonstrate the importance of precise wiring and resistor values in circuit design. The practical implementation showcased how theoretical designs translate into real-world applications, bridging the gap between simulation and hardware.

VIII. Limitations:

1. The circuit is designed only for valid BCD inputs (0000 to 1001). Inputs from 1010 to 1111 are invalid and result in no output.

2. The design is not scalable for systems requiring more than a single digit.

3. Power consumption increases with the number of connected seven-segment displays.

4. Manual switching for input is impractical for real-time applications; automation or microcontroller integration would be necessary for advanced use

IX. Conclusion

This project successfully demonstrates the design and implementation of a BCD to Decimal Converter using combinational logic and a common cathode seven-segment display. The circuit accurately converts 4-bit BCD inputs into their corresponding decimal digits and visually represents them on the display.

This project provides a practical understanding of digital electronics, particularly the application of logic gates and seven-segment displays. It also emphasizes the importance of combinational logic design in modern electronics.

~~~~~~ The End ~~~~~~
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