BBM233: Logic Design Lab
2024 Fall
Lab Experiment #3 Report

Mustafa Furkan Ateş,2220356176

November 5, 2024

1 Part 1

1.1 What is a 7-segment display and how it works?

A 7-segment display shows numbers by lighting up combinations of seven LEDs arranged in a figure-8 pattern. Each segment lights up individually to form digits, controlled by binary inputs and a decoder.

1.2 How many types of 7-segment display are there?

There are two types of 7-segment displays:

Common Cathode (CC): Segments light up with a positive voltage at the anodes. Common Anode (CA): Segments light up by grounding the cathodes. The difference is in how the voltage is applied to light the segments.

1.3 Why do we need a decoder

It simplifies the process of translating binary values into visual representations, ensuring that the correct segments light up for each digit from 0 to 9.

1.4 If this assignment were about designing a common anode instead of common cathode, would there be any change in truth table and if yes what kind of change?

the truth table outputs would be the logical complement of each other for the same BCD inputs.

1.5 What happens if you apply inputs for which you used don't cares (X), i.e. 8-15? What is shown on the 7-segment display and why?

Applying inputs 8-15 on a 7-segment display shows random or undefined patterns because these inputs were marked as don't cares (X) and don't correspond to valid digit outputs.

2 Part 2

Table 1: Truth Table for Common Cathode Decoder

Inputs				**Outputs**						
A	B	C	D	a	b	c	d	e	f	g
0	0	0	0	1	1	1	1	1	1	0
0	0	0	1	0	1	1	0	0	0	0
0	0	1	0	1	1	0	1	1	0	1
0	0	1	1	1	1	1	1	0	0	1
0	1	0	0	0	1	1	0	0	1	1
0	1	0	1	1	0	1	1	0	1	1
0	1	1	0	0	0	1	1	1	1	1
0	1	1	1	1	1	1	0	0	0	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	0	0	1	1

3 Part 3

$$a(A, B, C, D) = P(0, 2, 3, 5, 7, 8, 9) \tag{1}$$

		CD			
		00	01	11	10
AB	00	1	0	1	1
	01	0	1	1	0
	11	x	x	x	x
	10	1	1	x	x

$$a = A + \overline{B} \times \overline{D} + B \times D + \overline{B} \times C \tag{2}$$

$$b(A, B, C, D) = P(0, 1, 2, 3, 4, 7, 8, 9) \tag{3}$$

		CD			
		00	01	11	10
AB	00	1	1	1	1
	01	1	0	1	0
	11	x	x	x	x
	10	1	1	x	x

$$b = \overline{B} + \overline{C} \times \overline{D} + C \times D \tag{4}$$

$$c(A,B,C,D) = P(0,1,3,4,5,6,7,8,9) \tag{5}$$

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

$$c = \overline{C} + D + B \tag{6}$$

$$d(A,B,C,D) = P(0,2,3,5,6,8) \tag{7}$$

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

$$d = \overline{B} \times \overline{D} + \overline{B} \times C + C \times \overline{D} + B \times \overline{C} \times D \tag{8}$$

$$e(A,B,C,D) = P(0,2,6,8) \tag{9}$$

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

$$e = \overline{B} \times \overline{D} + C \times \overline{D} \tag{10}$$

$$f(A,B,C,D) = P(0,4,5,6,8,9) \tag{11}$$

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

$$f = B \times \overline{D} + \overline{C} \times \overline{D} + B \times \overline{C} + A \tag{12}$$

$$g(A,B,C,D) = P(2,3,4,5,6,8,9) \tag{13}$$

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

$$g = \overline{C} \times B + \overline{B} \times C + C \times \overline{D} + A \tag{14}$$

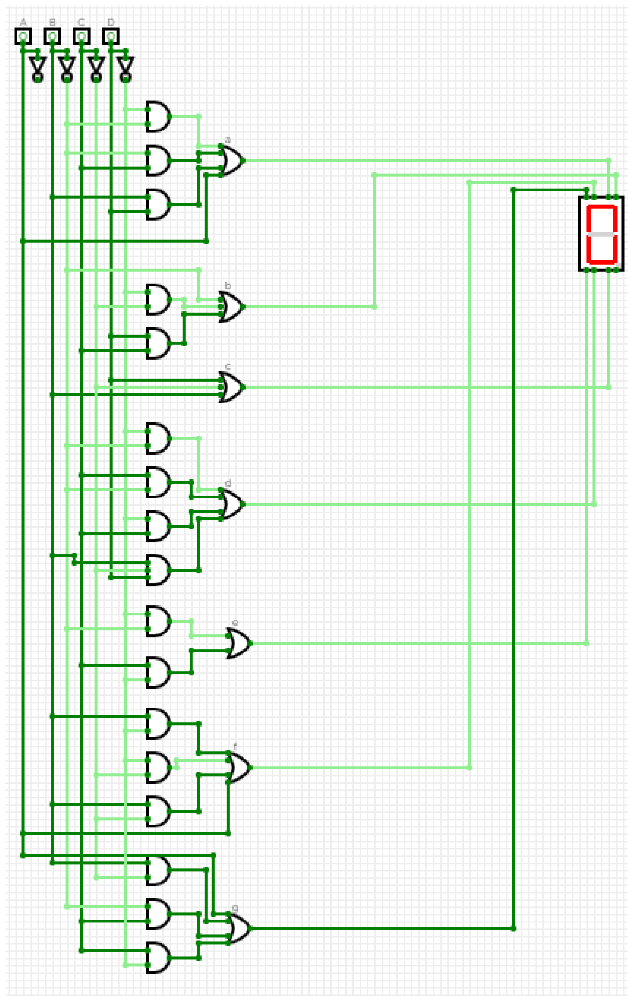

Figure 1: The BCD-to-7 Segment Display Decoder

4 Part 4 (Experiment 2)

A universal gate, often referred to as a functionally complete gate, is a type of logic gate capable of implementing any other logic gate. This means that using just one type of universal gate, you can construct circuits that perform any logical function.

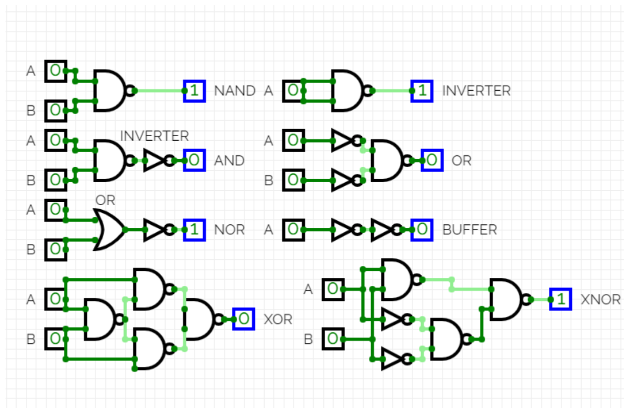

Figure 2: Implementing other gates using NAND

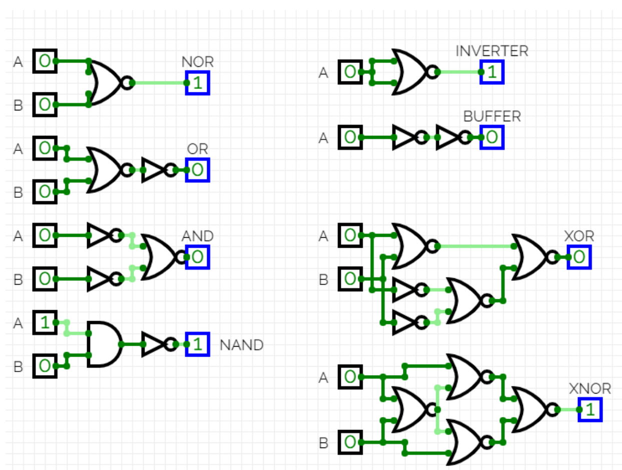

Figure 3: Implementing other gates using NOR

4.1 Use the formula you obtained from the K-Map and express it using only NAND gates.

$$a = \overline{A} \uparrow (A \uparrow B) \uparrow (\overline{B} \uparrow C) \uparrow (\overline{B} \uparrow \overline{D}) \tag{15}$$
$$b = B \uparrow (C \uparrow D) \uparrow (\overline{C} \uparrow \overline{D}) \tag{16}$$
$$c = \overline{B} \uparrow C \uparrow \overline{D} \tag{17}$$
$$d = (\overline{B} \uparrow D) \uparrow (C \uparrow \overline{D}) \uparrow (\overline{C} \uparrow D) \tag{18}$$
$$e = (\overline{B} \uparrow \overline{D}) \uparrow (C \uparrow \overline{D}) \tag{19}$$
$$f = \overline{A} \uparrow (\overline{B} \uparrow D) \uparrow C \tag{20}$$
$$g = \overline{A} \uparrow (B \uparrow \overline{C}) \uparrow (\overline{B} \uparrow C) \uparrow (C \uparrow \overline{D}) \tag{21}$$
$$\tag{22}$$

4.2 Using NOR gates

$$a = (A \downarrow \overline{B} \downarrow \overline{C} \downarrow \overline{D}) \downarrow (A \downarrow B \downarrow C) \tag{23}$$
$$b = (\overline{B} \downarrow \overline{C} \downarrow D) \downarrow (\overline{B} \downarrow C \downarrow \overline{D}) \tag{24}$$
$$c = \overline{(B \downarrow \overline{C} \downarrow D)} \tag{25}$$
$$d = (A \downarrow \overline{B} \downarrow C) \downarrow (A \downarrow \overline{B} \downarrow \overline{D}) \downarrow (A \downarrow C \downarrow \overline{D}) \tag{26}$$
$$e = (\overline{B} \downarrow C) \downarrow D \tag{27}$$
$$f = (A \downarrow \overline{B} \downarrow \overline{C}) \downarrow (A \downarrow \overline{C} \downarrow D) \tag{28}$$
$$g = (A \downarrow \overline{B} \downarrow \overline{C} \downarrow \overline{D}) \downarrow (A \downarrow B \downarrow C) \tag{29}$$
$$\tag{30}$$

References

- www.overleaf.com
- https://circuitverse.org/simulator