Bangladesh University of Engineering and Technology

Department of Computer Science and Engineering

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CSE 206
Digital Logic Design Sessional
Lab Report 1

Group No 2

Submitted by:

1805006 - Tanjeem Azwad Zaman

1805007 - Mehbubul Hasan Al-Quvi

1805008 - Abdur Rafi

1805009 - Md. Zarzees Uddin Shah

1805010 - Anwarul Bashir Shuaib

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Problem 1

1.1 Problem Specification

Simplify the equation using Boolean algebra and implement it.

$F(A, B, C, D) = A'B'C'D' + ABCD + ABC'D + A'B'CD' + A'BC'D + AB'C'D' + AB'CD' + A'BCD$

1.2 Required Instruments

1. IC-7404 (Quantity: 1)
2. IC-7408 (Quantity: 1)
3. IC-7432 (Quantity: 1)
4. Input Pins (Quantity: 4)
5. Output Pin (Quantity: 1)
6. Wires

1.3 Truth Table

A	**B**	**C**	**D**	**F**
0	0	0	0	1
0	0	0	1	0
0	0	1	0	1
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	1
1	1	1	0	0
1	1	1	1	1

1.4 Boolean Expression (with Simplification)

$$
\begin{aligned}
&F(A,B,C,D) \\
&= A'B'C'D' + ABCD + ABC'D + A'B'CD' + A'BC'D + AB'C'D' + AB'CD' + A'BCD \\
&= ABCD + A'BCD + ABC'D + A'BC'D + AB'CD' + A'B'CD' + AB'C'D' + A'B'C'D' \\
&= BD(AC + A'C + AC' + A'C') + B'D'(AC + A'C + AC' + A'C') \\
&= (BD + B'D')(AC + A'C + AC' + A'C') && [Since, AC + AB = A(B + C)] \\
&= (BD + B'D')(A(C + C') + A(C + C')) \\
&= (BD + B'D')(A.1 + A'.1) && [Since, X + X' = 1] \\
&= (BD + B'D')(A + A') && [Since, X.1 = X] \\
&= (BD + B'D').1 && [Since, X + X' = 1] \\
&= (BD + B'D')
\end{aligned}
$$

1.5 Circuit Diagram

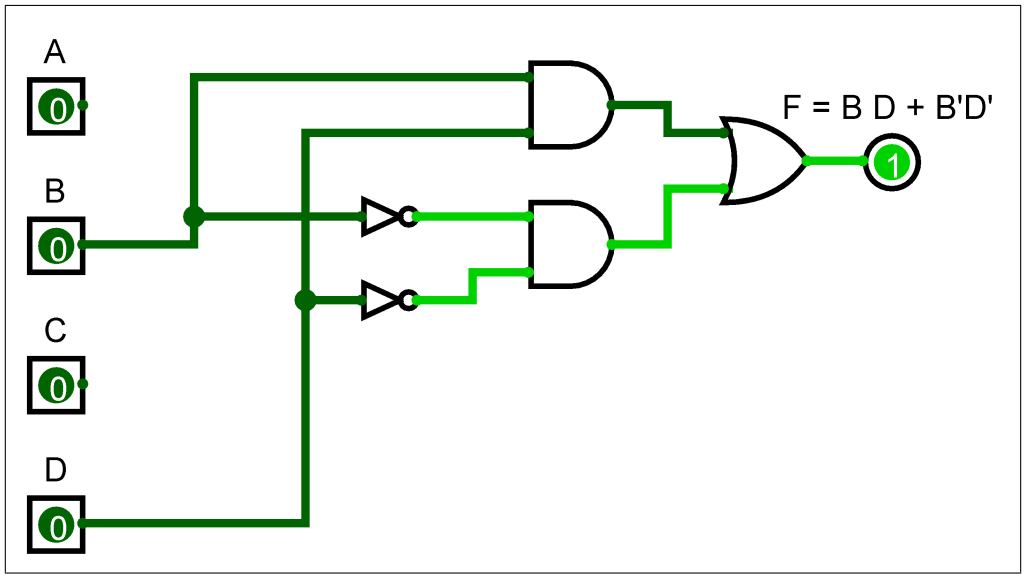

Figure 1: Circuit diagram for problem 1

1.6 Observations

- The original Boolean Expression can be simplified.
- For the simplified expression, the output is independent of the inputs A and C, and is only dependent on inputs B and D.
- Upon further inspection, we can see that the expression can be written as $(B \oplus D)'$

Problem 2

2.1 Problem Specification

Derive the equations for a 3 bit gray to binary converter from Truth table and implement those with the required gates.

2.2 Required Instruments

1. IC-7404 (Quantity: 1)
2. IC-7408 (Quantity: 3)
3. IC-7432 (Quantity: 1)
4. Input Pins (Quantity: 3)
5. Output Pin (Quantity: 3)
6. Wires

2.3 Truth Table

A	**B**	**C**	**X**	**Y**	**Z**
0	0	0	0	0	0
0	0	1	0	0	1
0	1	1	0	1	0
0	1	0	0	1	1
1	1	0	1	0	0
1	1	1	1	0	1
1	0	1	1	1	0
1	0	0	1	1	1

2.4 Boolean Expression (with Simplification)

$$
\begin{aligned}
X &= ABC' + ABC + AB'C + AB'C' \\
&= AB(C + C') + AB'(C + C') \\
&= AB + AB' \\
&= A(B + B') \\
&= A
\end{aligned}
$$

$$
\begin{aligned}
Y &= A'BC + A'BC' + AB'C + AB'C' \\
&= A'B(C + C') + AB'(C + C') \\
&= A'B + AB'
\end{aligned}
$$

$$
Z = A'B'C + A'BC' + ABC + AB'C'
$$

2.5 Circuit Diagram

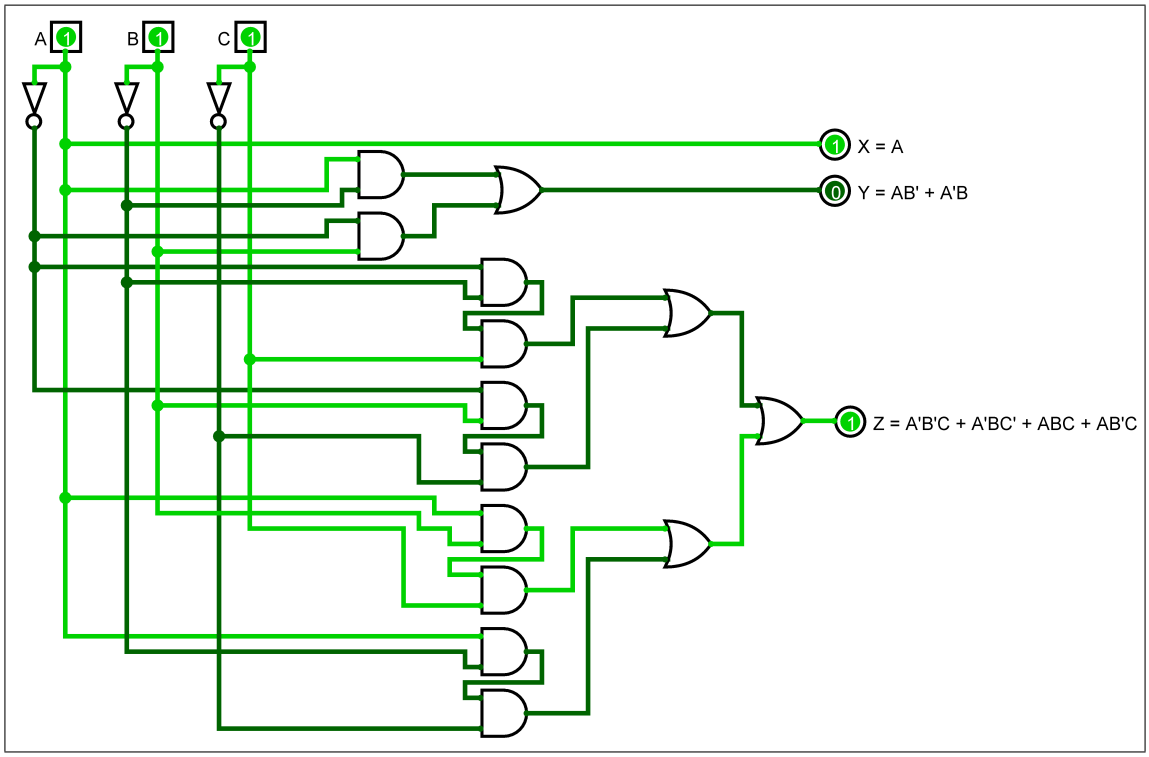

Figure 2: Circuit diagram for problem 2

2.6 Observations

- The most significant bit of the grey code remains unchanged in binary.
- The second most significant bit of the binary is found by taking *XOR* of the the first and second most significant bit of the gray code.
- For the least significant bit, no simplification can be made.

Problem 3

3.1 Problem Specification

Derive the truth table and corresponding output equations for the given condition and implement those with the required gates.

Condition: There are 3 inputs into a system. The system will glow LED1 and LED0 in such a way that the pattern represents the number of set bits in the input.

3.2 Required Instruments

1. IC-7404 (Quantity: 1)
2. IC-7408 (Quantity: 3)
3. IC-7432 (Quantity: 2)
4. Input Pins (Quantity: 3)
5. Output Pin (Quantity: 2)
6. Wires

3.3 Truth Table

A	**B**	**C**	**LED1**	**LED0**
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

3.4 Boolean Expression(with Simplification)

$$
\begin{aligned}
LED1 &= A'BC + AB'C + ABC' + ABC \\
&= BC(A + A') + AB'C + ABC' \\
&= BC + AB'C + ABC' \\
&= B(C + AC') + AB'C \\
&= B((C + A)(C + C')) + AB'C \\
&= B(A + C) + AB'C \\
&= AB + BC + AB'C \\
&= A(B + B'C) + BC \\
&= A((B + B')(B + C)) + BC \\
&= A(B + C) + BC \\
&= AB + BC + CA \\
LED0 &= A'B'C + A'BC' + AB'C' + ABC
\end{aligned}
$$

3.5 Circuit Diagram

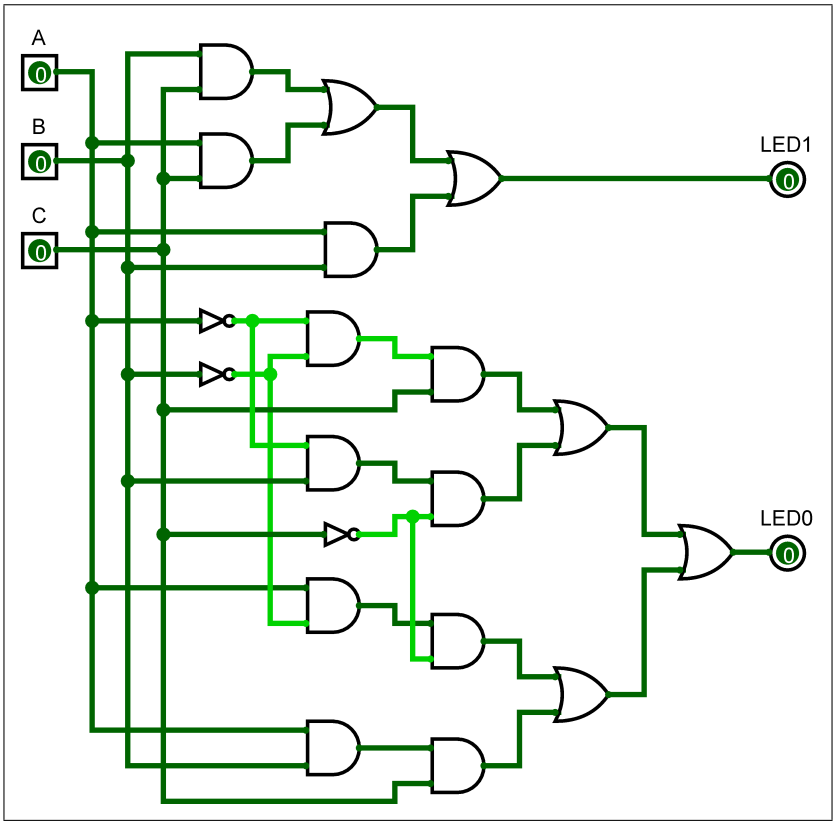

Figure 3: Circuit diagram for problem 3

3.6 Observations

- The Expression for LED0 can also be written as

$$C(A \oplus B)' + C'(A \oplus B) = A \oplus B \oplus C$$

- The expression for LED1 cannot be simplified further.
- Both the outputs are dependent on all three inputs.

Problem 4

4.1 Problem Specification

For the following logic function, find out the truth table, write down the logic expression. Simplify the logic expression as far as possible using Boolean algebra and then implement it.

$$F(A, B, C, D) = \sum(6, 9, 12, 15)$$

4.2 Required Instruments

1. IC-7404 (Quantity: 1)
2. IC-7408 (Quantity: 3)
3. IC-7432 (Quantity: 1)
4. Input Pins (Quantity: 4)
5. Output Pin (Quantity: 1)
6. Wires

4.3 Truth Table

A	**B**	**C**	**D**	**F**
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	0
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

4.4 Boolean Expression (with Simplification)

$$F(A, B, C, D) = A'BCD' + AB'C'D + ABC'D' + ABCD$$

4.5 Circuit Diagram

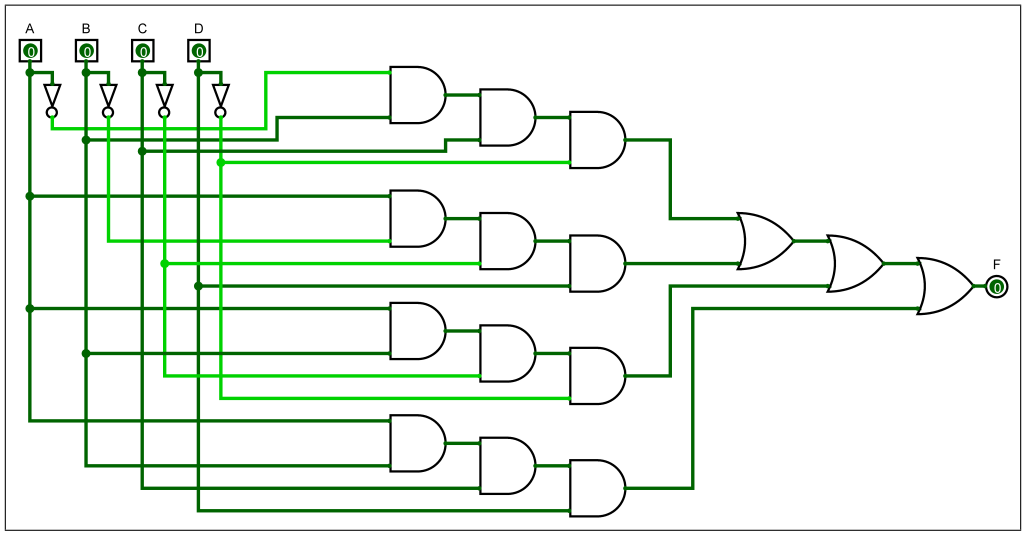

Figure 4: Circuit diagram for problem 4

4.6 Observations

This logic expression can not be simplified further. The output is dependent on all the four inputs.