Bangladesh University of Engineering and Technology

Course: CSE 206

Digital Logic Design Sessional

Experiment 2

Truth Tables and Simplification Using Boolean Algebra

Group No: 05

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Submission Date: 13/03/2021

Problem-1

Problem Specification:

In this problem, we have to simplify the following 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

Required Instruments:

1. Logisim software

2. 1 IC 7408

3. 1 IC 7432

4. 1 IC 7404

5. 4 input pins and 1 output pin

6. Electric wires

Truth Table:

A	B	C	D	Y
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

Simplification of Function:

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 + ABC’D + A’BCD + A’BC’D+ AB’CD’+ A’B’CD’+ AB’C’D’ + A’B’C’D’

= BD(AC+AC'+A'B+A’C’) + B’D’(AC+A’C++AC’+A’C’)

=BD{A(C+C’)+A’(C+C’)}+ B’D’{A(C+C’)+A’(C+C’)}

=BD(A+A’)(C+C’) + B’D’(A+A’)(C+C’)

=BD+B’D’ [A+A’=1 & C+C’=1]

=(B ⊕ D)’

This is the simplest form of the given expression.

Circuit Diagram:

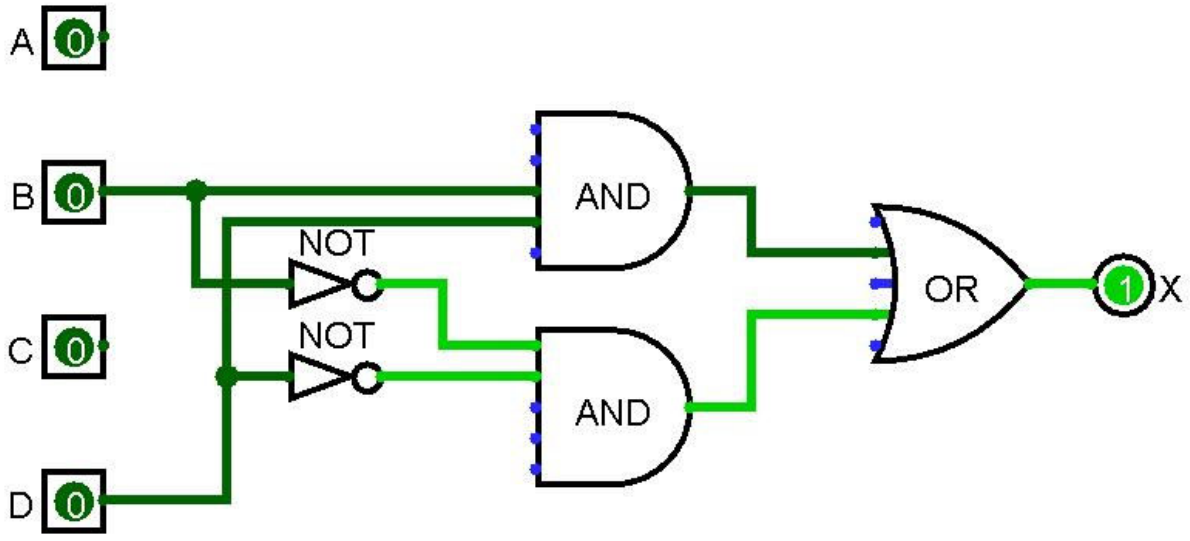

Figure: Problem-1

Observation:

Here, we can observe that the output does not depend on the input signal of A and C. The output signal is basically the XNOR operation of the B and D input signal.

Problem-2

Problem Specification: We have to create Boolean functions from the truth table of gray code and binary code and then implement the gray to the binary converter from the Boolean functions using basic gates.

Required Instruments:

No	Name	Quantity
1	IC(Quad 2 input AND)	1 piece
2	IC(Quad 2 input OR)	1 piece
3	IC(Hex - Inverter)	1 piece
4	Wires	A lot
5	Input Pins	3
6	Output Pins	3

Truth Table:

Gray Code			Binary Code		
G2	G1	G0	B2	B1	B0
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

B2 = G2G1G0’ + G2G1G0 + G2G1’G0 + G2G1’G0’

=G2G1(G0’+G0) + G2G1’(G0+G0’)

=G2G1 + G2G1’

=G2(G1+G1’)

= G2

B1 =G2’G1G0 + G2’G1G0’ + G2G1’G0 + G2G1’G0’

=G2’G1(G0 + G0’) + G2G1’(G0+G0’)

=G2’G1 + G2G1’

=G2 ⊕ G1

B0 =G2’G1’G0 + G2’G1G0’ + G2G1G0 + G2G1’G0’

=G2’(G1’G0 + G1G0’) + G2(G1G0 + G1’G0’)

=G2’(G1 ⊕ G0) + G2((G1 ⊕ G0)’)

=G2 ⊕ G1 ⊕ G0

Circuit Diagram:

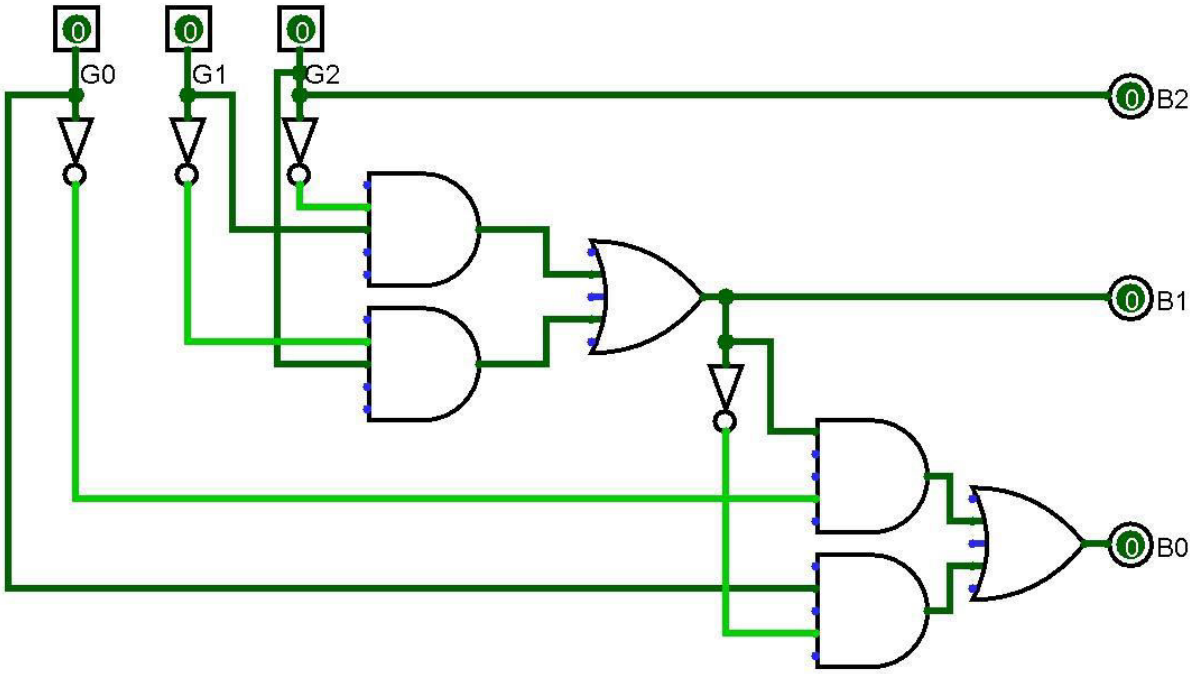

Figure: Problem 2(Gray to Binary Converter)

Observations: If we observe the Boolean function for each binary bit, we see that while converting Gray code to binary, the MSB is the same as the Gray code's MSB and other binary bits are the result of the XOR operation with the previous output bit.

Problem-3

Problem Statement:

In this problem, we need to 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.

Required Instruments:

Item	Quantity
Trainer Board	1 piece
7404 IC chip	1 piece
7408 IC chip	2 pieces
7432 IC chip	1 piece
Input pins	3 pieces
LED	2 pieces
Wires	A lot

Truth Table:

In this problem we need to represent the number of set bits of three inputs: A, B, C by two LEDs: LED0 and LED1. LED0 represents the least significant bit here. The truth table for the problem:

Input			**Output**	
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

Derived Equation:

From the truth table, we can derive equations for LED0 and LED1.

LED0 = A'B'C + A'BC' + AB'C' + ABC

= A'(B'C+BC') + A(B'C'+BC)

= A'(B⊕C) + A(B⊕C)'

= A ⊕ B ⊕ C

LED1 = A'BC + AB'C + ABC' + ABC

= AB(C + C') + A'BC + AB'C

= AB + A'BC + AB'C

= B(A + A'C) + AB'C

= B(A + A')(A+C) + AB'C [By distributive law]

= AB + BC +AB'C

= AB + C(B + AB')

= AB + C(B+A)(B+B') [By distributive law]

= AB + BC + CA

Circuit Diagram:

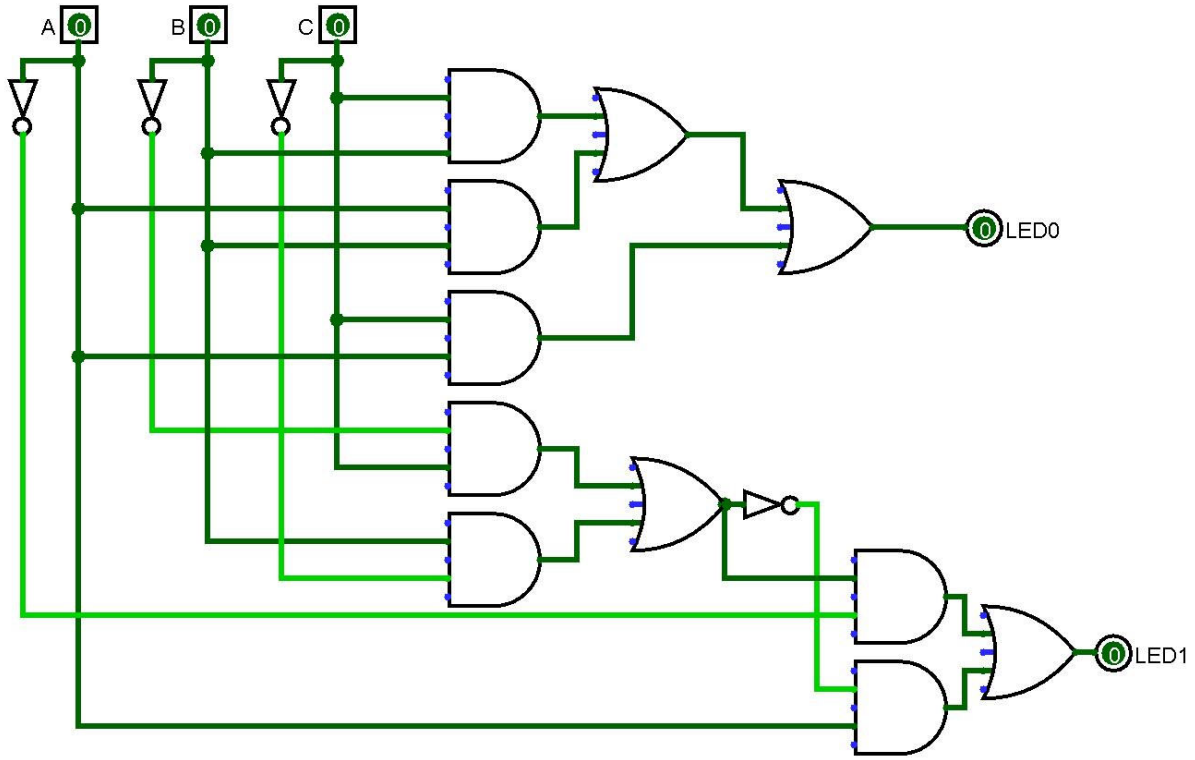

Figure: Circuit diagram for problem 3

Observations:

From the truth table, we can see that LED1 will glow if the number of set bits is at least two and LED0 will glow if there are odd numbers (1 or 3) of set bits in the inputs.

Problem-04

Problem Specification:

In this problem, we have to find out the truth table for the following logic function: $F(A, B, C, D) = \sum (6, 9, 12, 15)$, write down the logic expression associated with it. We also need to simplify the logic expression as far as possible using Boolean Algebra and then implement it.

Required Instruments:

Serial No.	Item Name	Quantity Required
1	Trainer Board	1 piece
2	Hex Inverter (7404 IC chip)	1 piece
3	Quad 2 Input 7408 IC chip	4 pieces
4	Quad 2 Input 7432 IC chip	1 piece
5	Input Pins	4 pieces
6	Output Pins	1 piece
7	Electric Wires	Sufficient

Truth Table:

A	B	C	D	Result
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

Required Equation:

From the rightmost column we can see that input combinations from row (starting with 0 index) 6, 9, 12, 15 produces the desired output. The equation we get is:

A’BCD’+AB’C’D+ABC’D’+ABCD

Circuit Diagram:

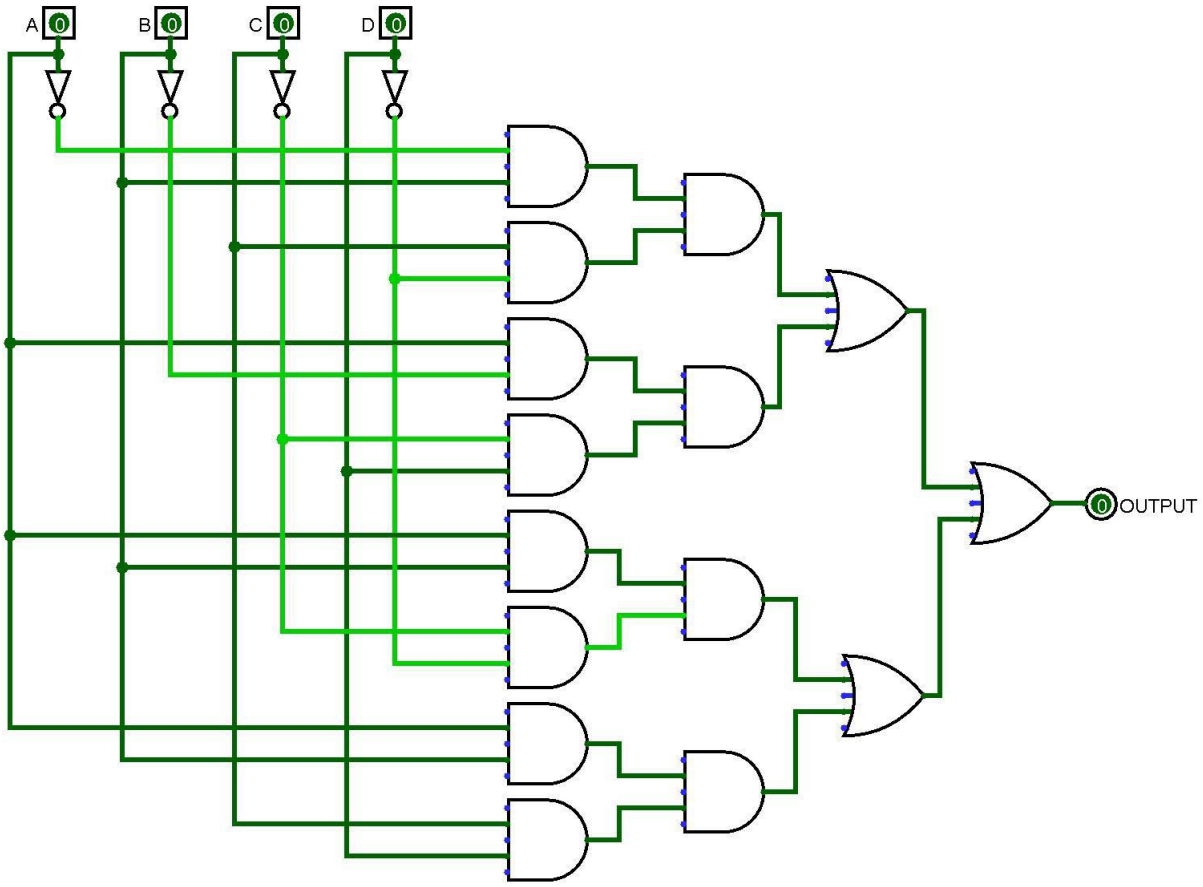

Figure: Circuit Diagram: Problem 4

Observations:

From the truth table and equation we got, it is clear that the input combinations from row number 6, 9, 12 and 15 produce the output. Surprisingly, this is the simplified form itself to be implemented with IC.