EEE-1212:Digital Logic Design Lab

1st Year 2nd Semester
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Experiment Number: 04

Name of the Experiment:

Realization of the given condition using only Basic gates

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Name of the experiment: A 4-bit binary number is represented as $A_3\ A_2\ A_1\ A_0$ where A_3, A_2, A_1, A_0 represent the individual bits with A_0 equal to the LSB. Design a logic circuit that will produce a HIGH output whenever the binary number is greater than 0010 and less than 1000

Objective: The objective of this lab is to design a logic circuit using the basic gates and get the expected output from the circuit that can fulfill the given condition.

Theory:

Step 1. Set up the truth table.
On the basis of the problem statement, the output *x* should be HIGH(1) whenever the binary number is greater than 0010 and less than 1000; for all other cases, the output should be LOW(0) (Table -3(b)).

Step 2. Write the AND term for each case where the output is a 1.
There are five such cases. The AND terms are shown next to the truth table (Table 4-2). Again note that each AND term contains each input variable in either inverted or non-inverted form.

Step 3. Write the sum-of-products expression for the output.

$$X = A_0A_1\bar{A}_2\bar{A}_3 + \bar{A}_0\bar{A}_1A_2\bar{A}_3 + A_0\bar{A}_1A_2\bar{A}_3 + \bar{A}_0A_1A_2\bar{A}_3 + A_0A_1A_2\bar{A}_3$$

Rules of simplification: Boolean algebra finds its most practical use in the simplification of logic circuits. We can simplify a given expression using Boolean algebra and can implement the circuit with fewer components. Here are some mostly used rules:

1. $A + A = A$
2. $A + \overline{A} = 1$
3. $A \,.\, A = A$
4. $A \,.\, \overline{A} = 0$
5. $\overline{A + B} = \overline{A} \,.\, \overline{B}$
6. $A \,.\, (A + B) = A$+A.B
7. $A \,.\, (\overline{A} + B) = A \,.\, B$
8. $A + 1 = 1$
9. $A \,.\, A = 0$
10. $B \,.\, (A + \overline{A}) = B$
11. $A \,.\, (B + C) = A.B + A.C$
12. $\bar{A} + AB = \bar{A} + B$

Any logic expression can be simplified using these rules.

Step 4. Simplify the output expression by using the following rules:

$$X = A_0A_1\bar{A}_2\bar{A}_3 + \bar{A}_0\bar{A}_1A_2\bar{A}_3 + A_0\bar{A}_1A_2\bar{A}_3 + \bar{A}_0A_1A_2\bar{A}_3 + A_0A_1A_2\bar{A}_3$$

$$= \bar{A}_3(A_0A_1\bar{A}_2 + \bar{A}_0\bar{A}_1A_2 + A_0\bar{A}_1A_2 + \bar{A}_0A_1A_2 + A_0A_1A_2)$$

$$= \bar{A}_3(A_0A_1(\bar{A}_2 + A_2) + \bar{A}_1A_2(A_0 + \bar{A}_0) + \bar{A}_0A_1A_2)$$

$$= \bar{A}_3(A_0A_1 + \bar{A}_1A_2 + \bar{A}_0A_1A_2)$$

$$= \bar{A}_3(A_1(A_0 + \bar{A}_0A_2) + \bar{A}_1A_2)$$

$$= \bar{A}_3(A_1(A_0 + A_2) + \bar{A}_1A_2)$$

$$= \bar{A}_3(A_0A_1 + A_2(A_1 + \bar{A}_1))$$

$$= \bar{A}_3(A_0A_1 + A_2)$$

Instruments:

1. Trainer Board
2. 2 IC(s) IC-7408,IC-7432,IC-7400
3. Connecting wires

Procedure:

1. At first we placed three integrated circuits(IC)s AND, OR, NOT gates on a breadboard properly. The ICs are placed across the gap in the center of the breadboard.

2. Then we simplified the given expression by removing common factors among various product terms.

3. Then we implemented the logic circuits using the gates on the breadboard with switches and LED. We connected the inputs with switches and the output with an LED. The output of the circuit will be shown on the LED. (LED Off = 0, LED On = 1).

4. We gave biasing to the ICs with the VCC (5 volt) and GND (0 volt), and do necessary connections according to the circuit diagram shown below.

5. We observed outputs for various input combinations.

6. Verified the truth table of the circuit.

Result:

So we can see the output of the following gates is equal to the simplified form of the given expression.

Truth Table 3(b):

Input				Output
A	B	C	D	X
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

By using the following truth table we gave this logic circuit:

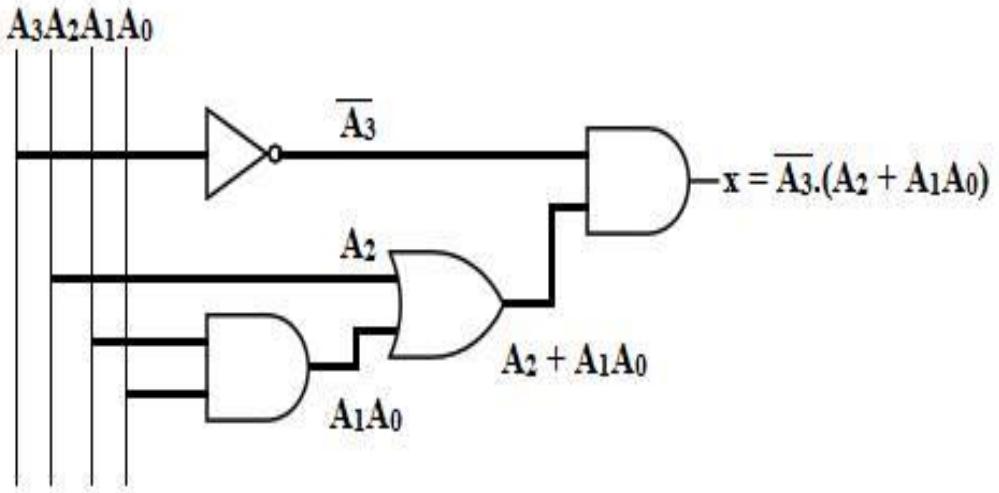

Fig: Logic circuit of the given condition

Discussion:

In this experiment we worked with IC's and verified the truth table of the given expression by using only Basic gates. We simplified the expression by applying Boolean algebra and was able to implement the circuit with fewer components. But we faced some problems when we doing this experiment.

i) In this experiment we used three IC(s) for the first time. So we need any wires to connect this IC(s) with each other. At first we faced some problems to do this work.

ii) At first we gave A_3 ,A_2 A_1 and A_0 reverse connection .For example we gave connection A_3 in place A_1 and A_1 in place of A_3. So we didn't get expected output for the first time. That's why we need a little bit more time to complete the experiment.

iii) Besides, we also faced some technical difficulties when using trainer board. The input gates weren't working properly and the output LED was also not functioning properly. So we changed this board and started our work with another trainer board.

But we figured them out and completed the experiment successfully.