EEE-1212:Digital Logic Design Lab

1st Year 2nd Semester
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Experiment Number: 02

Name of the Experiment:

Realization of the given expression using only NAND gates

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Name of the experiment: Realization of the given expression using only NAND gates

Objective: The objective of this lab is to realize and simplify a given expression and implement the circuit using only NAND gates and verify it using truth table.

Theory:

A logic gate is an idealized or physical device implementing a Boolean function; that is, it performs a logical operation on one or more logical inputs, and produces a single logical output.A truth table is a means for describing how a logic circuit's output depends on the logic levels present at the circuit's inputs.There are seven logic gates. Among them, AND gate, OR gate and NOT gate is called basic gates. Their working principle are described below:

AND Gate: The AND gate is an electronic circuit that gives a high output (1) only if all its inputs are high otherwise it gives low output (0). A dot (.) is used to show the AND operation i.e. A.B.

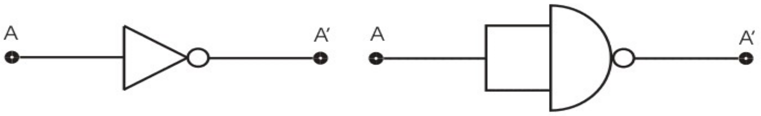
OR Gate: The OR gate is an electronic circuit that gives a high output (1) if one ormore of its inputs are high otherwise it gives low output (0). A plus (+) is used to show the OR operation.

NOT Gate: The NOT gate is an electronic circuit that produces an inverted version of the input at its output. It is also known as an inverter. If the input variable is A, the output is known as NOT A.

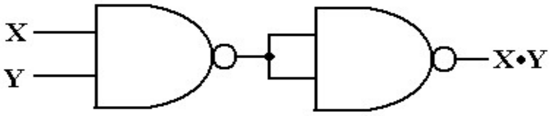
NAND and NOR gate are called universal gates.Using only NAND gate, any logic circuit can be implemented.

NAND Gate: The NAND gate is an electric circuit that gives a low output (0) if it's all input is high (1) otherwise it gives high output(1). Actually it operates like an AND Gate followed by an inverter.

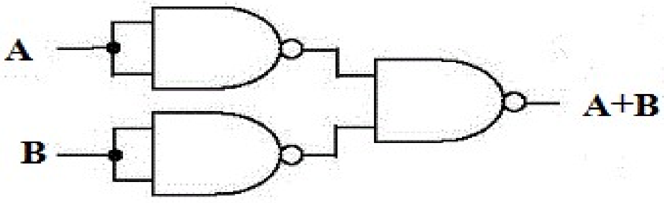
Implementation of NOT gate using NAND gate:



Implementation of AND gate using NAND gate:



Implementation of OR gate using NAND gate:



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. $A \,.\, (A + B) = A$
7. $A \,.\, \left(\overline{A} + B\right) = A \,.\, B$
8. $A + 1 = 1$
9. $A \,.\, A = 0$
10. $B \,.\, (A + \overline{A}) = B$
11. $A \,.\, (B + C) = A.B + A.C$
12. $\overline{A \,.\, B} = \overline{A} + \overline{B}$

Any logic expression can be simplified using these rules. For example:

$$\begin{aligned} X &= \bar{A}\bar{B}\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}D \\ &= \bar{B}\bar{C}(\overline{A} + A) + \overline{A}\,\overline{B}\,D \\ &= \overline{B}\,\overline{C} + \overline{A}\bar{B}\,D \qquad \text{[From equation (2)]} \\ &= \overline{B}(\,\overline{C} + \overline{A}\,D\,) \end{aligned}$$

Instruments:

1. Trainer Board
2. 2 IC(s) IC-7400 (NAND gates)
3. Connecting wires

Procedure:

1. At first we placed the two integrated circuits(IC) with NAND 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 NAND 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).

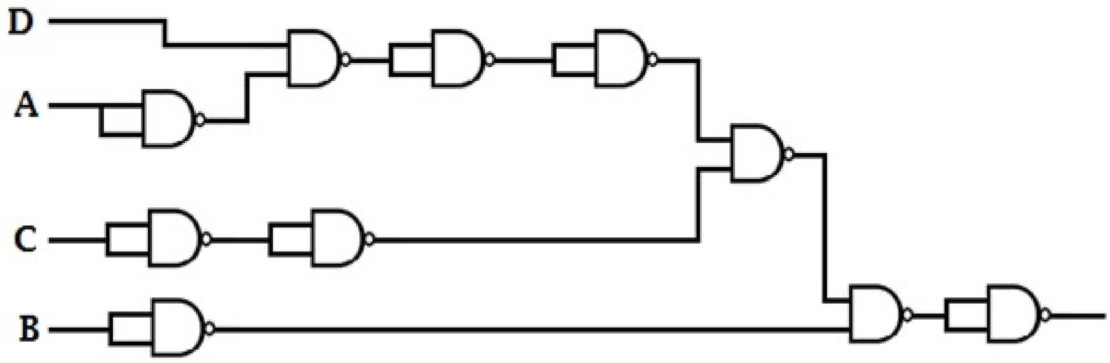
4. We gave biasing to the ICs with the VCC (5 volt) and GND (0 volt), and do necessary connections according to the circuit diagram shown below.

5. We observed outputs for various input combinations.

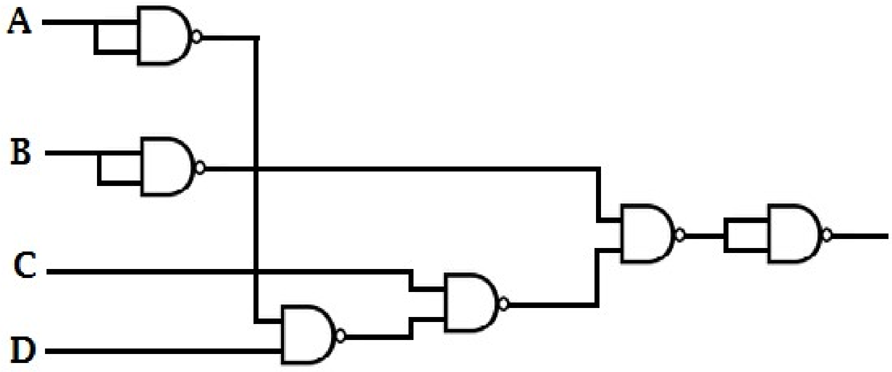
6. Verified the truth table of the circuit.

Result:

IC N0: 7400



We know that two consecutive NAND gates with same input cancels each other. Hence, the circuit can be further simplified as shown below:



From the following gates we get these equation:

$$= \overline{\overline{\bar{A}D} \,.\; C}$$
$$= \overline{\overline{\bar{A}D}} + \bar{C}$$
$$= \overline{\left(\bar{A}D + \bar{C}\right).\,\overline{B}}$$
$$= \overline{\bar{A}D + \bar{C}} + B$$
$$= (\overline{\bar{A}D} \,.C) + B$$
$$= \left((A + \bar{D}).C\right) + B$$
$$= \overline{\left((A + \bar{D}).C\right) + B}$$
$$=(\bar{A}D + \bar{C}).\bar{B}$$

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

Truth Table:

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

Discussion:

In this experiment we worked with IC's and verified the truth table of the given expression by using only NAND gates. But we faced some problems when we doing this experiment .

i) In this experiment we used two IC(s) for the first time. At first we faced some problems to work with two IC(s) .

ii) In this experiment, we need six NAND gates. So we need too many wires to connect this gates with each others. We also face some problems to do this work.

iii) Besides this at first we started our work with one trainer board But after a few minutes we realized that there have some problems in this board. So we changed this board and started our work with another trainer board.

But we figured them out and completed the experiment successfully .