American International University- Bangladesh
Department of Electrical and Electronic Engineering
EEE 2206: Digital Logic Design Laboratory

Title: Study of Universal Gates.

Introduction:

A Logic Gate which can infer any of the gate among Logic Gates or a gate which can be used to create any Logic gate is called Universal Gate. **NAND and NOR** Gates are called Universal Gates because all the other gates such as NOT, AND, OR, XOR, XNOR etc can be created by using these gates

The Objective of this lab is to implement different logic functions using universal gates.

Theory and Methodology:

NAND gate:

The graphic symbol for the NAND gate consists of an AND symbol with a bubble on the output, denoting that a complement operation is performed on the output of the AND gate.

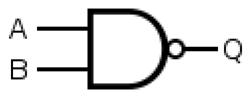


Fig 2.1: Symbol of NAND gate

Output, Q=$\overline{AB}$=$\bar{A}$ +$\bar{B}$

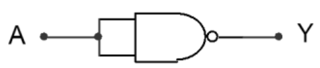
Truth Table

Input A	Input B	Output Q
0	0	1
0	1	1
1	0	1
1	1	0

It is possible to construct other gates using NAND gates which are shown in Experimental procedure part.

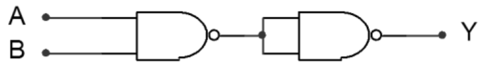
Implementing various logic functions using NAND Gates:

1) Implementing NOT gate using NAND gate:



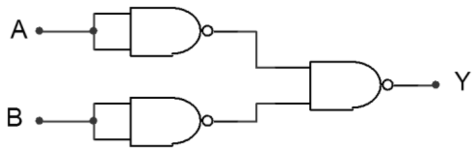
NOT gate using NAND gate

2) Implementing AND gate using NAND gate:



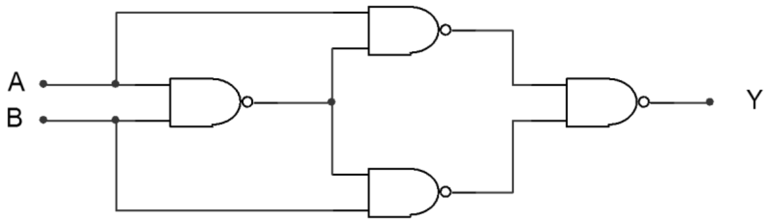
AND gate using NAND gates

3) Implementing OR gate using NAND gate:



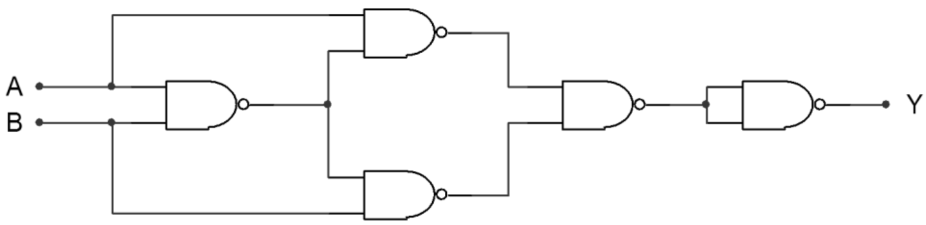
OR gate using NAND gates

4) Implementing XOR gate using NAND gate:



XOR gate using NAND gates

5) Implementing XNOR gate using NAND gate:



XNOR gate using NAND gates

NOR gate:

The **NOR** gate represents the complement of the OR operation. It's name is an abbreviation of **N**OT **OR**. The graphic symbol for the NOR gate consists of an OR symbol with a bubble on the output, denoting that a complement operation is performed on the output of the OR gate. The truth table and the graphic symbol of NOR gate is shown in the figure.

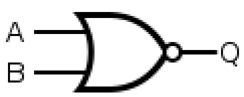


Fig 2.2: Symbol of NOR gate

Output,Q=$\overline{A+B}$=$\bar{A}\,\bar{B}$

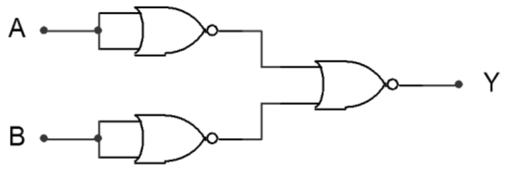
Truth Table		
Input A	**Input B**	**Output Q**
0	0	1
0	1	0
1	0	0
1	1	0

Implementing various logic functions using NOR Gates:

1) Implementing NOT gate using NOR gate:

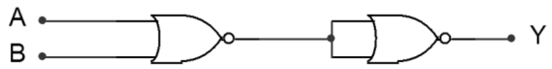
NOT gate using NOR gate

2) Implementing AND gate using NOR gate:



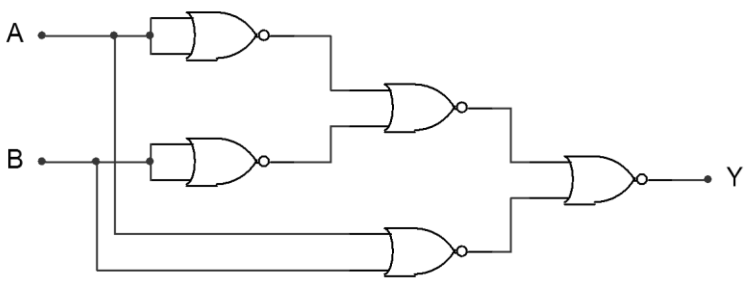
AND gate using NOR gates

3) Implementing OR gate using NOR gate:



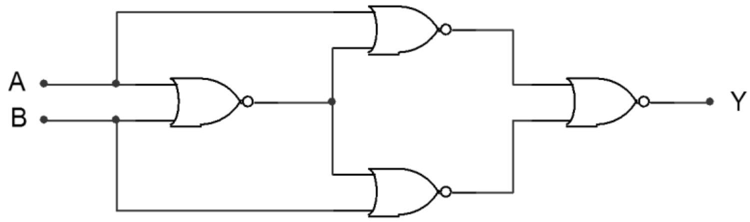
OR gate using NOR gates

4) Implementing XOR gate using NOR gate:



XOR gate using NOR gates

5) Implementing XNOR gate using NOR gate:



XNOR gate using NOR gates

Pre-Lab Homework:

Students must study the Boolean algebra rules and universal gates, perform simulation of the circuits shown in the theory section using Multisim and MUST present the simulation results to the instructor before the start of the experiment.

Apparatus:

1. Digital trainer board.
2. Integrated Circuits (ICs).
3. Power supply.
4. Connecting wires.

Precautions:

Have your instructor check all your connections after you are done setting up the circuit and make sure that you apply only enough voltage to turn on the chip, otherwise it may get damaged.

Experimental Procedure:

1. Construct an XOR and XNOR gate in your trainer board by using NAND gates only. Use required IC to construct the circuit.
2. Find out the equivalent NOT, OR and AND gate by using NOR gates only. Now construct an XOR and XNOR gate in your trainer board by using NOR gates only. Use required IC to construct the circuit.
3. Convert the following expressions using universal gates and implement them in the trainer board. Compare the results with the truth table of the equations.
   i) A (+) B
   ii) (A(+)B) +C
   iii) (AB +CD)’

Simulation and Measurement:

Compare the simulation results with your experimental data/ wave shapes and comment on the differences (if any).

Questions with answers for report writing:

1) What do you mean by universal gate?
2) What are the ICs required in this experiment?
3) Construct a circuit of output F, where F=AB + BC + CA, by using NAND gates only.

Discussion and Conclusion:

Interpret the data/findings and determine the extent to which the experiment was successful in complying with the goal that was initially set. Discuss any mistake you might have made while conducting the investigation and describe ways the study could have been improved.

Reference(s):

1) www.tutorialspoint.com
2) www.electronics-tutorials.ws
3) faculty.kfupm.edu.sa
4) "Digital Fundamentals" by Thomas L. Floyd