AROR UNIVERSITY
OF ART, ARCHITECTURE,
DESIGN & HERITAGE,
SUKKUR, SINDH

Faculty of Artificial Intelligence & Multimedia Gamming

BS – Artificial Intelligence (Section A)

Digital Logic Design Lab

Lab # 02: NAND, NOR, XOR, and XNOR Gate

Instructor: Abdul Ghafoor

Submission Profile

Name: Submission date (dd/mm/yy):

Marks obtained:

Comments:

Instructor

Lab Learning Objectives:

Upon successful completion of this experiment, the student will be able:

- To explore the function of various different logic gates
- To create circuits with varying logic gates in theory and in practice

Platform: NI ELVIS III	✔ View User Manual: http://www.ni.com/en-us/support/model.ni-elvis-iii.html ✔ View Tutorials: https://www.youtube.com/playlist?list=PLvcPIuVaUMIWm8ziaSxv0gwtshBA2dh_M
Hardware: Digilent Digital Electronics Board for NI ELVIS III	✔ View NI DSDB Board Manual: http://www.ni.com/pdf/manuals/376627b.pdf
Software: NI Multisim 14.0.1 Education Version or newer	✔ Install Multisim: http://www.ni.com/gate/gb/GB_ACADEMICEVALMULTISIM/US ✔ View Help: http://www.ni.com/multisim/technical-resources/
Software: NI LabVIEW FPGA Vivado 2014.4	✔ Install: http://www.ni.com/download/labview-fpga-module-2015-sp1/5920/en/ **Note:** Digilent Driver (The installer above automatically downloads the installer below onto your computer) ✔ Navigate to: C:\NIFPGA\programs\Vivado2014_4\data\xicom\cable_drivers\nt64\digilent

✔ Install: install_digilent.exe

Lab Hardware and Software Required:

Background Theory:

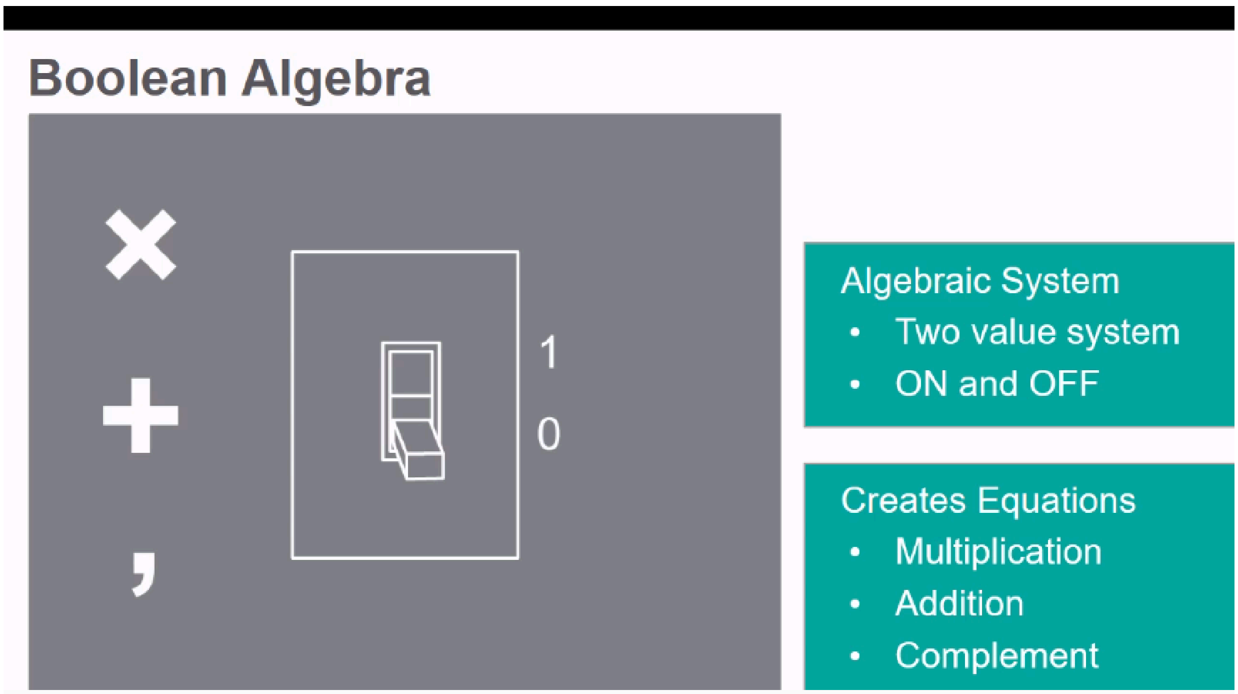


Figure 1-1 Video. View the video here: https://youtu.be/1wnztS6et0w

Video Summary

- NAND, NOR, XOR, and XNOR gates have at least two inputs, one output, and a unique truth table
- NOT gate output is the inverse of the input

List of Logic Gate ICs

The 7400 series has several ICs for basic logic gates in TTL family.

IC No.	Gate
7400	NAND
7402	NOR
7404	NOT
7408	AND
7432	OR
7486	EX-OR
4077	XNOT (CMOS family)

Inverters

- Inverters are also known as *NOT* gates.
- They have only one input and one output.
- The truth table for an inverter is simple. The output is always the *opposite* of the input.
- For example, if the input is 1, the output will be 0 and vice versa. Visually this is depicted by a circle at the input and/or output ends of the logic gates.
- In this situation, the circle is at the output, which means that the output is inverted. If it was at the input, then it is the input that would be inverted.
- Circuits with more than one input can use NAND or NOR logic gates which we will explore next.

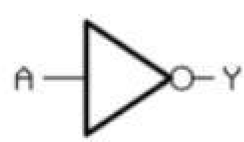


Figure 1-2 Inverter

NAND Logic Gates

- *NAND* gates invert the output of the AND gate.
- The inputs do not change from those of the AND truth table, but the output is the opposite.
- As a rule, if any of the inputs are 0, the output will always be 1.
- See below for the truth table and the symbol.

A	B	O
0	0	1
0	1	1
1	0	1
1	1	0

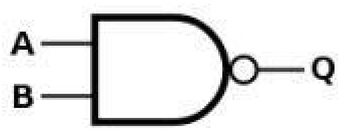


Figure 1-3 NAND gate truth table and symbol

NOR Logic Gates

- The *NOR* logic gate inverts the output of the OR gate.
- The inputs of the truth table for the OR gate do not change, but the output is the opposite.
- As a rule, if any of the inputs are 1, the output will always be 0.
- See below for the truth table and symbol.

A	B	O
0	0	1
0	1	0
1	0	0
1	1	0

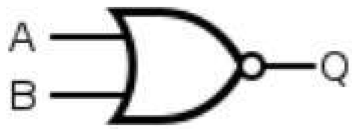


Figure 1-4 NOR gate truth table and symbol

XOR Logic Gates

- An *XOR* gate is also known as an exclusive OR gate.
- The output will be 1 if only one of the inputs is 1. The output will be 0 if both inputs are 0 or both are 1.
- See below for the truth table and symbol.

A	B	O
0	0	0
0	1	1
1	0	1
1	1	0

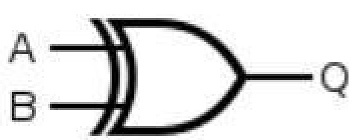


Figure 1-5 XOR gate truth table and symbol

XNOR Logic Gates

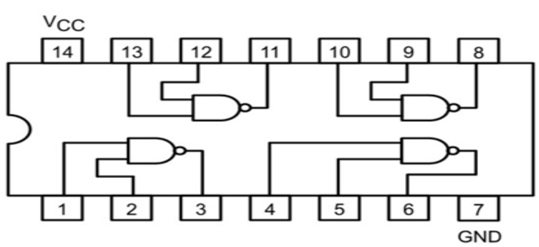
- The *XNOR* gate does the opposite of the XOR gate.
- The output will be 1 if the inputs are the same and the output will be 0 if the inputs are not the same.
- See below for the truth table.

A	B	O
0	0	1
0	1	0
1	0	0
1	1	1

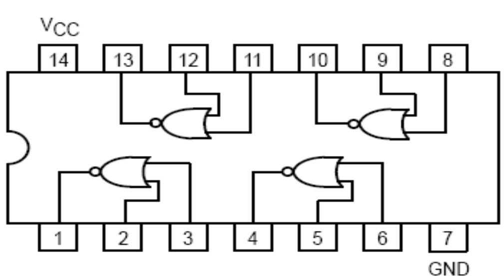
Figure 1-6 XNOR gate truth table

Exercise 1: Implementation of following ICs' on NI Elvis kit using Digital Reader and Digital Writer

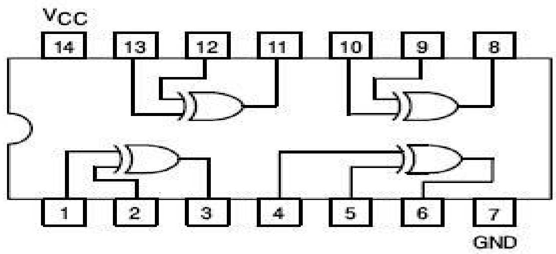
74LS00 2-input NAND gate IC:



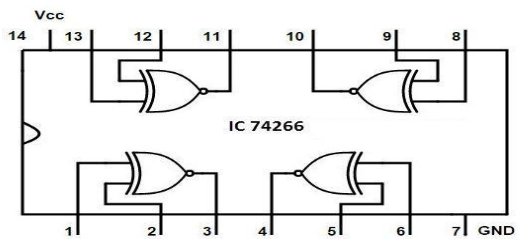
74LS02 2-Input NOR Gate IC:



74LS86 2-Input XOR Gate IC:



74LS266 2-Input XNOR Gate IC:



Exercise 2: Building an XOR Logic Gate in Multisim

XOR Gate Circuit

Build the following circuit using an XOR gate:

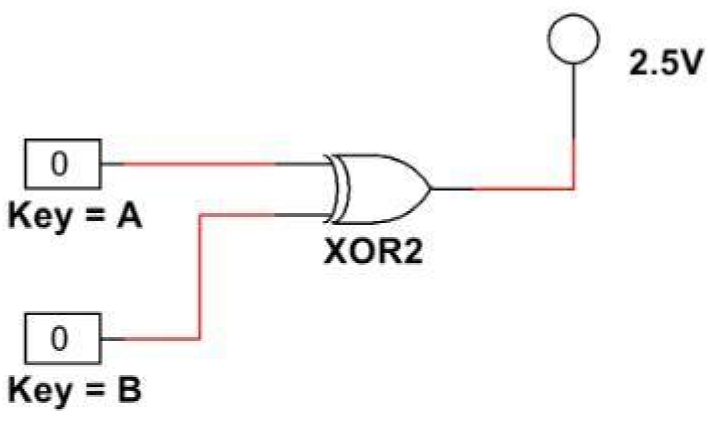


Figure 1-18 XOR gate circuit

Configure the Digital Constants:

- Double-click the top **Digital Constant**.
- In the window that appears, select '**A**' from the Key for toggle dropdown.
- Change the second constant to toggle with the '**B**' key.
- Click the **Run** to begin simulating the circuit.

Figure 1-19 Run button

- Press the '**A**' key on the keyboard to change the value of that input to **1**.

2-1 Does the probe turn on?

A. Yes
B. No

- Press the '**A**' key again to change the top input back to **0**.
- Press the '**B**' key to change the second input to **1**.

2-2 Does the probe turn on?

A. Yes
B. No

- Press the '**A**' key, so that both inputs are equal to **1**.

2-3 Does the probe turn on?

A. Yes
B. No

2-4 How would you describe the behavior of this gate?

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- When you're done, stop the simulation by clicking the **Stop** button.

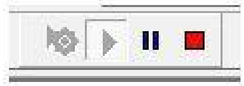

Figure 1-20 Stop button

Exercise 3: Building a NOR Logic Gate on the Digital Electronics Board

Using the switches, LEDs, and logic gates, create the following circuit:

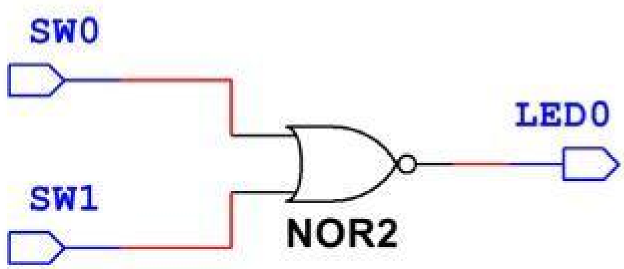

Figure 1-21 PLD design

Configure the Digital Constants:

- Double-click the top **Digital Constant**.
- In the window that appears, select '**A**' from the Key for toggle dropdown.
- Change the second constant to toggle with the '**B**' key.
- Click the **Run** to begin simulating the circuit.

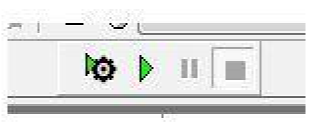

Figure 1-22 Run button

- Press the '**A**' key on the keyboard to change the value of that input to **1**.

3-1 Does the probe turn on?

C. Yes
D. No

- Press the '**A**' key again to change the top input back to **0**.

- Press the '**B**' key to change the second input to **1**.

3-2 Does the probe turn on?

C. Yes
D. No

- Press the '**A**' key, so that both inputs are equal to **1**.

3-3 Does the probe turn on?

C. Yes
D. No

3-4 How would you describe the behavior of this gate?

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- When you're done, stop the simulation by clicking the **Stop** button.

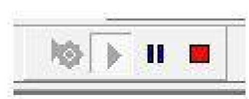
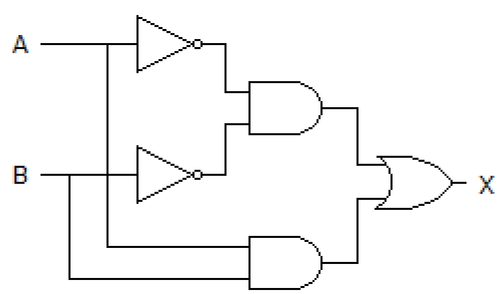


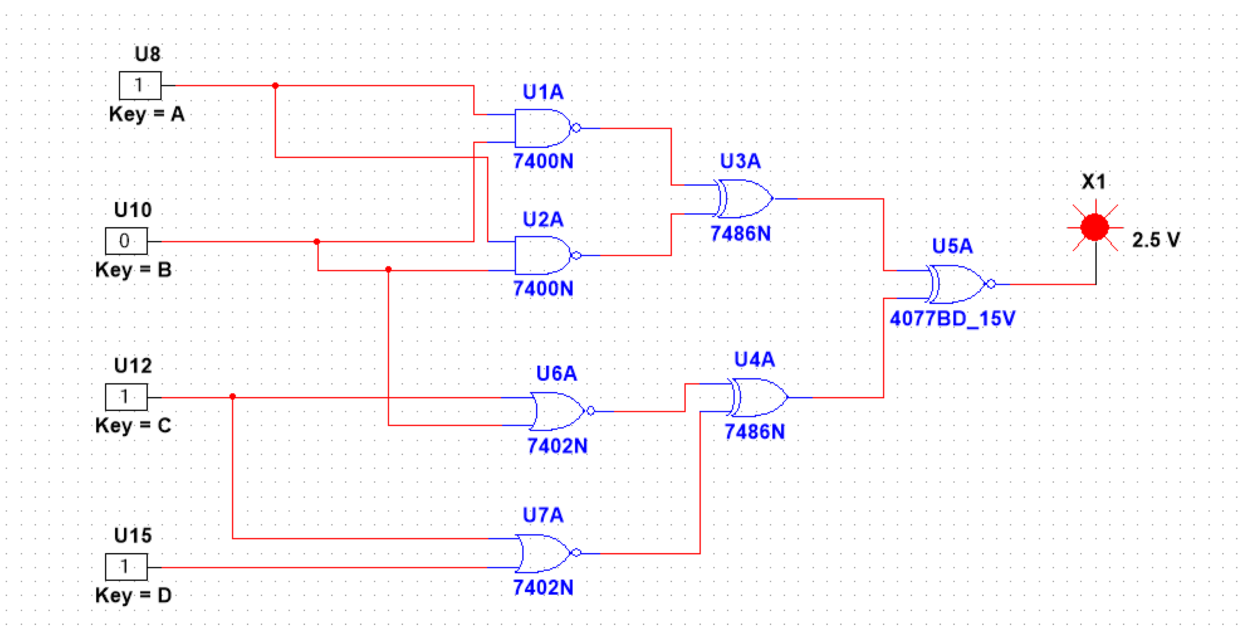
Figure 1-23 Stop button

Exercise 4: Design the following circuit on multisim and show the results with truth table.



A	B	Output
0	0	
0	1	
1	1	
1	0	

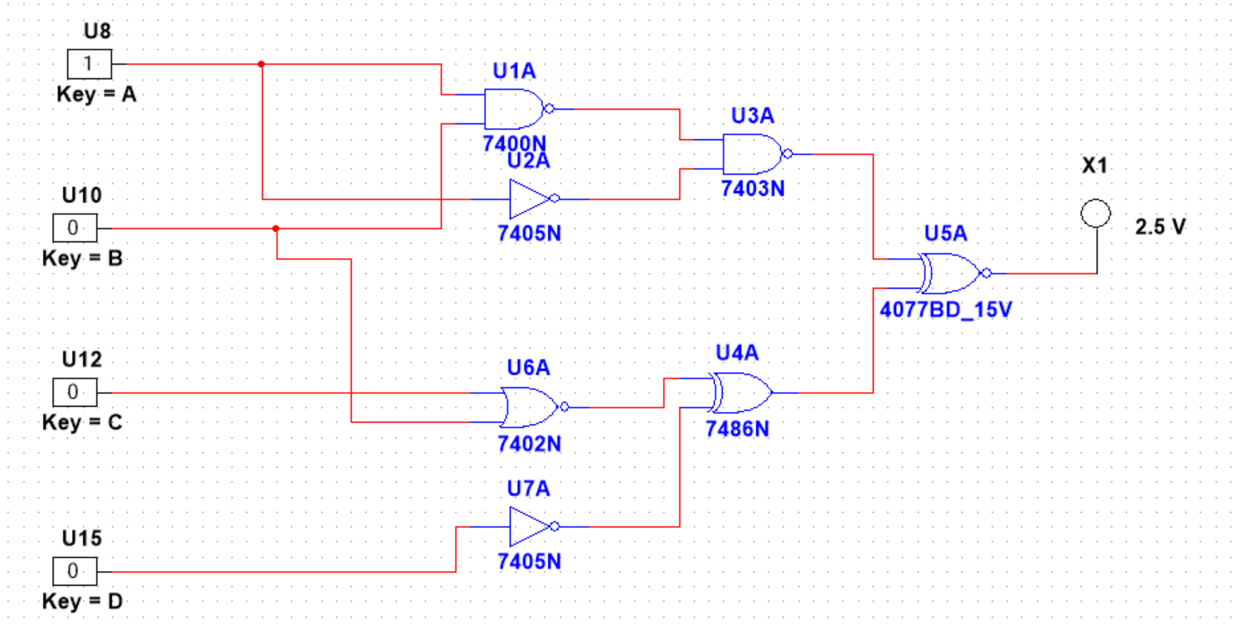
Exercise 5: Design the following circuit on multisim and show the results with truth table.



A	B	C	D	Output
0	0	0	1	
0	0	0	1	
0	1	0	1	
0	1	0	1	
1	0	1	0	

1	0	1	0	
1	1	1	0	
1	1	1	0	

Exercise 6: Design the following circuit on multisim and show the results with truth table.



A	B	C	D	Output
0	0	0	1	
0	0	0	1	
0	1	0	1	
0	1	0	1	
1	0	1	0	
1	0	1	0	
1	1	1	0	
1	1	1	0	