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Experiment No.2

EX-OR & EX-NOR Gates

1. Introduction

Digital logic gates are the fundamental building blocks of modern electronic systems, enabling the processing and manipulation of binary data. Among these, the XOR (Exclusive OR) and XNOR (Exclusive NOR) gates hold a unique position due to their versatile applications in arithmetic operations, error detection, and digital comparators.

1.1 Objective

This experiment aims to explore the functionality, truth tables, and practical implementations of XOR and XNOR gates using basic logic components. Additionally, the experiment will highlight the differences between XOR and XNOR gates.

1.2Components

The CircuitMaker software is used to design and simulate logical circuits.

1.3Theory

a- The Exclusive-OR gate

The ***exclusive-OR gate*** is referred to as the “any but not all” gate. The exclusive-OR term is often shortened to read as ***XOR.*** A truth table for the **XOR** function is shown in Fig. 1**.** Careful examination shows that this truth table is similar to the OR

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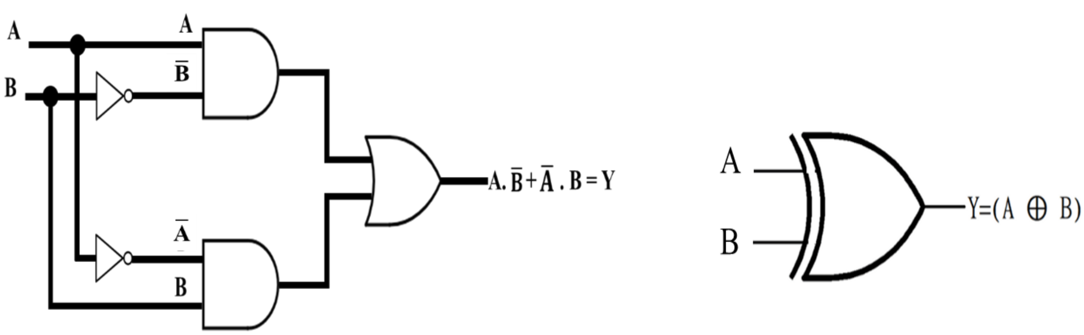
truth table except that when both inputs are **1,** the **XOR** gate generates a 0. The **XOR** gate is enabled ***only when an odd number*** of 1s ***appears at the inputs.***

Lines **1** and **4** of the truth table contain even numbers (0,2) of **1s,** and therefore the **XOR** gate is disabled and a 0 appears at the output. The XOR gate could be referred to as an odd-bit check circuit.

The Boolean expression of XOR is $\mathbf{A.\overline{B}+\overline{A}\,.\,B=A\oplus B}$



(a) Logic circuit that performs the XOR function

(b) Standard logic symbol for the XOR gate

Figure 1

b. The Exclusive-NOR gate

X- NOR gate represents the complement of X-OR gate, logic symbol is shown in Fig. 8. The XOR gate produces the expression$\mathbf{A\oplus B}$. When this is inverted, it forms the Boolean expression for the XNOR gate, $\overline{\mathbf{A\oplus B}}$ = **Y**

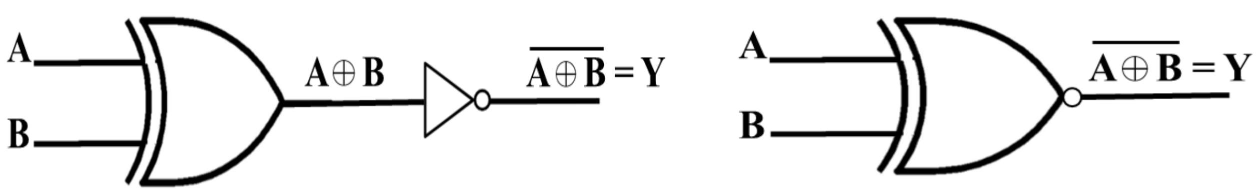


Figure 2

Note that all outputs of the XNOR gate are the complements of the XOR-gate outputs. While the XOR gate is an odd-number-of-1s detector, the XNOR gate detects *even numbers* of 1s. The XNOR gate will produce a 1 output when an *even number* of 1*s* appear at the inputs.

Input		Output	
B	A	XOR	XNOR
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

Figure 3: The XOR and XNOR gate truth tables

Experiment

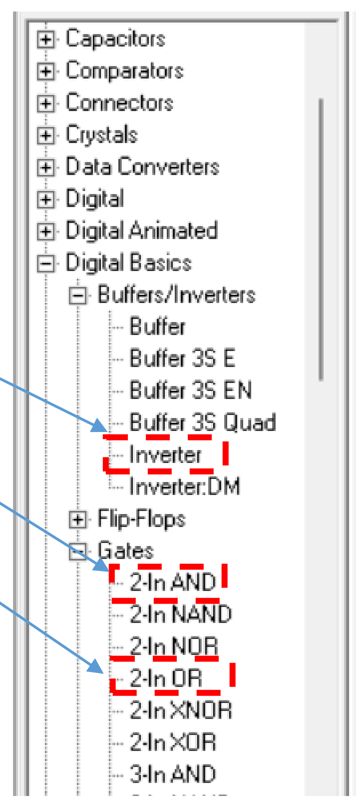
Using CircuitMaker software to design the XOR and XNOR by using the AND, OR, and NOT logic gates.

Following these steps:

1- Choose two NOT gates

2- Choose two AND gates.

3- Choose one OR gates



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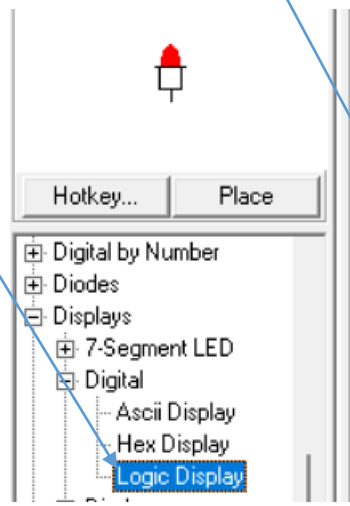
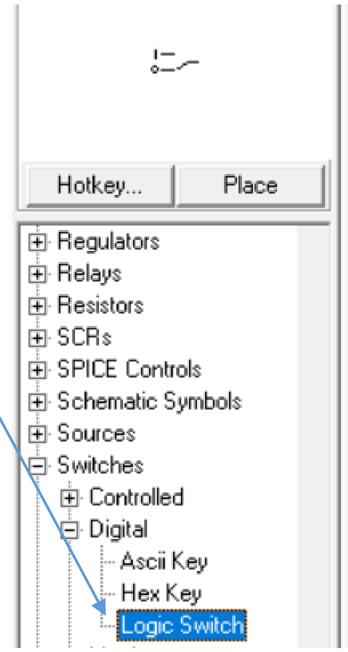
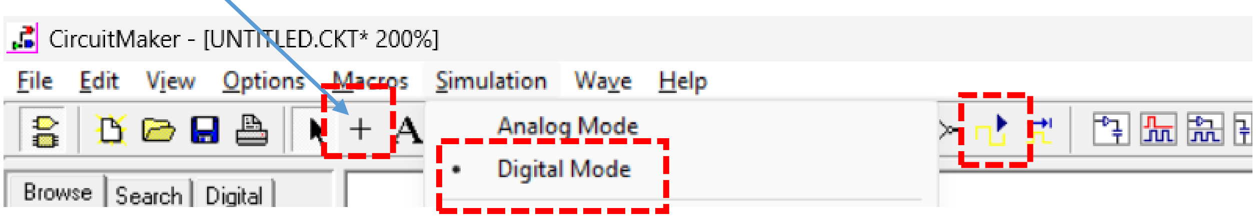
4- Choose two switches to represent the inputs

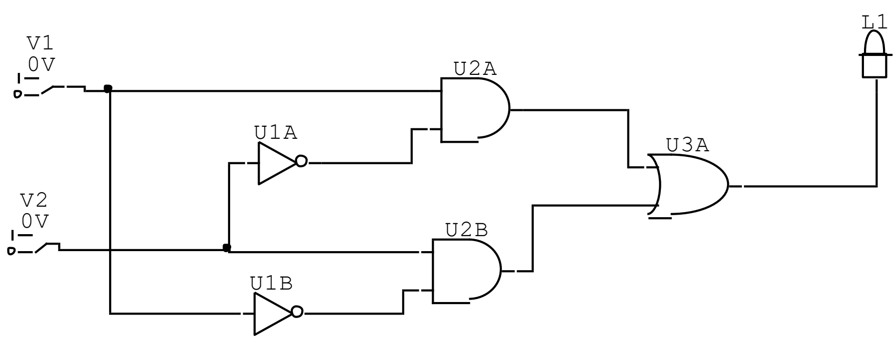
5- Choose one LED to display the output





From the + sign, connect between the components as shown in the figure below





When the circuit connection is done, choose the digital mode from the simulation list and then press run.

6- Create the truth table

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Discussion:

1- Illustrate the truth table for the experiment

2- Compare the result with the truth table in Fig 3.

3- What are the key differences between XOR and XNOR gates in terms of their truth tables?

4- What are the Boolean expressions for XOR and XNOR gates?

5- Draw a truth table for XOR and XNOR gates with four inputs.