George Mason University

Physics 311

Digital Circuits I

Introduction

In this lab-experiment, you will explore logic gates and combinational circuits.

Digital logic circuits (gates) operate in the binary mode where the inputs have only two possible states, a binary 1 represented normally by a HIGH voltage and a binary 0 represented normally by a LOW voltage. Digital logic can be developed with the use of logic symbols and the Boolean algebra equations that define the logic. Logic gates are electronic circuits that combine digital signals in specific patterns according to the dictates of the related Boolean algebra equation. The basic logic gates that we will study are

1. The NAND gate
2. The inverter or NOT gate
3. The AND gate
4. The OR gate
5. The NOR gate
6. The EXOR Gate
7. The EXNOR Gate

All gate circuits are to be built using the NAND Gate 7400 (Pin – id see data sheet).

Assignment #1:

The NAND Gate

The NAND gate is a circuit that provides a binary zero or LOW at its output if all of its inputs are HIGH. If any of its inputs are binary zeros, then the output will be HIGH. The Boolean expression for a two input NAND gate is $\overline{A \cdot B} = Y$. A 7400 has four NAND gates, which can be connected to form other logical circuit combinations.

Connect the IC to +5 V (DC). Apply a signal (in accordance with the binary zeros and ones listed in the truth table) to the inputs A and B of one of the gates and determine the output. You can use a DMM to measure the output voltage. Insert the values into the table and copy it into your lab notebook.

NAND Gate Truth Table			
B	**A**	**Y**	**Voltage**
0	0		
0	1		
1	0		
1	1		

Assignment #2:

The AND Gate:

Create an AND gate using only NAND gates and fill in the truth table with the detected values. Copy the truth table into your lab notebook and draw a circuit diagram. **Do not use the internet to find the correct circuit. Use your own logic.**

AND Gate Truth Table		
B	**A**	**Y**
0	0	
0	1	
1	0	
1	1	

Assignment #3:

The OR Gate:

Build an OR gate using only NAND gates and fill in the truth table with the detected values. Draw a circuit diagram.

OR Gate Truth Table		
B	**A**	**Y**
0	0	
0	1	
1	0	
1	1	

Convert the OR gate from above into a NOR gate. Fill in the truth table with the detected values and draw a circuit diagram.

NOR Gate Truth Table		
B	**A**	**Y**
0	0	
0	1	
1	0	
1	1	

Assignment #4:

The EXOR Gate:

Build an EXOR gate using only NAND gates. Draw the circuit diagram and fill in the truth table with the measured values. What do you need to change to convert this circuit into an EXNOR circuit?

EXOR Gate Truth Table		
B	A	Y
0	0	
0	1	
1	0	
1	1	

Assignment #5:

Building the circuit to a Boolean equation:

You have given the following Boolean equation. Construct a circuit with NAND gates that fulfills this equation. Write a truth table and draw a circuit diagram:

$$Y = (A + B)BC + A$$