Digital NOR and NAND Gates:

Video Link

TinkerCad Link

NOR Gate Table:

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Nand Table:

A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1

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

Questions:

1. In Figs A-2.5 and A-2.6, what voltage level would a binary 1 represent? A binary 0? Are the answers the same for both circuits of Figs. A-2.5 and A-2.6?

   In Figs A-2.5 a binary 1(high) would represent 29 mV and a binary 0(low) would represent 1.89 V. In Fig A-2.6 a binary 1(high) would represent 28.3 mV and a binary 0(low) would represent 1.89 V. The Binary 1 values are nearly the same and the binary 0 values are the same.

2. What is a NOR Gate? For what percentage of the time is it off?

   A NOR Gate is a type of logic gate that takes 2 or more inputs to create a single output. In the 3-input NOR gate logic, the output is high(1) only if all of the inputs are low(0), otherwise the output will be low(0). The NOR Gate is off 87.5% of the time.

3. What is a NAND Gate? For what percentage of the time is it on?

   A NAND Gate is a type of logic gate that takes two or more inputs, to create a single output. In a 3-input logic gate, the output is high(1) the majority of the time, and it is only low(0) if all three inputs are high(1).It is on 87.5% of the time.

4. What function do the diodes perform in the NOR and NAND gates?

In the NOR gate the diodes help create an OR gate which is then put through the transistor being used as a NOT gate. When an input is high the diode allows current to flow through the resistor to the base of the transistor, which activates the transistor. When this transistor is on the current gets grounded resulting in a low output. When the inputs are off, the diodes don't conduct current so the transistor does not activate. This lets the current only pass to the LED from the collector resulting in a high output.

In a NAND gate the diodes create an AND gate, whose output is put through a transistor, which acts like a NOT gate. When all inputs are HIGH(1) the diodes let current flow to ground, which lets enough current flow from the 10KΩ resistor to the base of the transistor which turns it on. When the transistor is on it grounds the current resulting in the output being LOW..

5. What are the fundamental differences between the two circuits shown in Fig. A-2.5 and Fig A-2.6? Do the differences significantly affect overall outcomes? Explain?

   a) The fundamental differences between these figures are the Fig. A-2.5 is a NOR gate circuit and Fig. A-2.6 is a NAND gate circuit. This makes a difference as a NAND is on majority of the time and a NOR gate is off majority of the time.

   b) Another fundamental difference is that Fig. A-2.5 has a resistor connected to ground and Fig. A-2.6 has a resistor connected to Vcc. This difference is significant in Fig. A-2.5 as when the resistor is connected to Vcc, the LED is always on.

      The difference is significant in Fig. A-2.6, as if the resistor is connected to ground, the LED will always be powered. This is because there is no current flowing through the inputs to ground thus the transistor doesn't become powered. The resistor connected to the collector is always powering the LED.

   c) Another fundamental difference is that the diodes in Fig. A-2.5 are forward biased and the diodes in Fig A-2.6 are reverse biased. When the diodes are forward biased they conduct current towards the transistor and do not let current flow back into the circuit. However in Fig A-2.6 the diodes are reverse biased meaning that they flow current into the inputs and do not let the current from the inputs flow out. This makes significant changes as if the diodes were flipped in Fig A-2.5 the inputs would not conduct any current, thus the transistor would not become activated, eventually leading to the LED always staying on.

      After that if the diodes were forward biased in Fig A-2.6, then the current from the 1KΩ(which is connected to Vcc) will go through the 10KΩ resistor and always activate the transistor as it has a voltage of 0.7 V. This means that the current that is flowing to the collector goes straight to ground and won't power the LED.

Experiment Results Report

Experiment No: 3
Title: Digital NOR and NAND Gates
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Date: 11/09/24
Class: Computer Technology
Instructor: Mr. Andrew Andrade

Explain the purpose of this experiment: To build Nand and Nor Gates without using Integrated Circuits.

List First Learning Objective: Build a Diode NOR Gate

How it is demonstrated: This objective was validated as the circuit I created worked as it showed a low(0) output when an input was high(1) and vice versa. It was also validated as I used diodes to create it

List Second Learning Objective: Build a Diode NAND Gate

How it is demonstrated: This objective was validated as the circuit I created worked as it showed low(0) output when all 3 inputs were high(1). Otherwise the output was always high(1). It was also validated as I used diodes to create the circuit.

List Third Learning Objective: Construct a truth table for a gate circuit

How it is demonstrated: This objective was validated as the truth table I created for the 3-input NAND and NOR gates, and they corresponded with other truth tables I found online.

Conclusion: In conclusion this lab was completed successfully, with all learning objectives being met.