Digital NOR and NAND Gates:

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) corresponds to 29 mV, while a binary 0 (low) corresponds to 1.89 V. In Fig. A-2.6, a binary 1 (high) represents 28.3 mV, and a binary 0 (low) again represents 1.89 V. The values for binary 1 are almost identical, and the values for binary 0 are the same in both figures.

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 two or more inputs and produces a single output. In a 3-input NOR gate, the output is high (1) only when all inputs are low (0); in all other cases, 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 and produces a single output. In a 3-input NAND gate, the output is high (1) most of the time, and it is only low (0) when all three inputs are high (1). The NAND gate is on 87.5% of the time.

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

In a NOR gate, the diodes form an OR gate, which is followed by a transistor acting as a NOT gate. When an input is high, the diode allows current to flow through the resistor to the base of the transistor, turning it on. When the transistor is active, it grounds the current, resulting in a low output. When the inputs are off, the diodes do not conduct current, so the transistor remains inactive. This allows current to flow to the LED from the collector, producing a high output.

In a NAND gate, the diodes create an AND gate, whose output is then passed through a transistor functioning as a NOT gate. When all inputs are HIGH (1), the diodes allow current to flow to ground, which in turn lets enough current flow through the 10kΩ resistor to the base of the transistor, turning it on. When the transistor is on, it grounds the current, resulting in a low output.

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 difference between these figures is that **Fig. A-2.5** represents a NOR gate circuit, while **Fig. A-2.6** represents a NAND gate circuit. This distinction is important because a NAND gate remains on the majority of the time, whereas a NOR gate is off most of the time.

b) Another key difference is that **Fig. A-2.5** has a resistor connected to ground, while **Fig. A-2.6** has a resistor connected to Vcc. This difference is significant in **Fig. A-2.5** because, with the resistor connected to Vcc, the LED remains on. In contrast, in **Fig. A-2.6**, when the resistor is connected to ground, the LED will always be powered since no current flows through the inputs to ground, preventing the transistor from turning on. As a result, the resistor connected to the collector continuously powers the LED.

c) Another major difference is that the diodes in **Fig. A-2.5** are forward-biased, while the diodes in **Fig. A-2.6** are reverse-biased. In **Fig. A-2.5**, when the diodes are forward-biased, they conduct current towards the transistor and prevent current from flowing back into the circuit. However, in **Fig. A-2.6**, the reverse-biased diodes allow current to flow into the inputs but block current from flowing out. This causes significant changes: if the diodes in **Fig. A-2.5** were reversed, the inputs would not conduct current, and the transistor would not activate, causing the LED to remain on. Conversely, if the diodes in **Fig. A-2.6** were forward-biased, the current from the 1kΩ resistor (connected to Vcc) would flow through the 10kΩ resistor, constantly activating the transistor, which would then ground the current, preventing the LED from being powered.

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 by the successful operation of the circuit I created. It displayed the expected behavior, showing a low (0) output when the input was high (1), and a high (1) output when the input was low (0), consistent with the logic of the gate. Additionally, the use of diodes in the circuit design further validated the logic, as they played a key role in shaping the input-output relationship, aligning with the intended functionality of the gate.

List Second Learning Objective: Build a Diode NAND Gate

***ow it is demonstrated:** This objective was validated by the successful operation of the circuit I created. The output was low (0) only when all three inputs were high (1), and in all other cases, the output remained high (1), which aligns with the expected behavior of the NAND gate. Additionally, the use of diodes in the circuit design further validated the logic, as they played a crucial role in controlling the input-output relationship, confirming the correct functioning of the gate.

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

How it is demonstrated: This objective was validated by comparing the truth table I created for the 3-input NAND and NOR gates with other truth tables I found online. The outputs in my truth table matched those in the reference tables, confirming the accuracy of my circuit's behavior and demonstrating that the gates functioned as expected.

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