Digital Logic Design Laboratory

Lab 1

Introduction Simulation Software and Logic Gates

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Class: DLD Lab

Date: 30/3/2024

# I. Objectives

In this laboratory, students will study:

- Familiar with simulation software

- Understand the operation of logic gates.

- Build a combination circuit that implements a Boolean expression.

- Use IC designing circuit which is satisfied the below truth table.

# II. Procedure

1. Investigate Logic Gates

Investigate the basic logic gates by using simulation software

a. NOT gate

- One input of NOT gate wire up to switch.

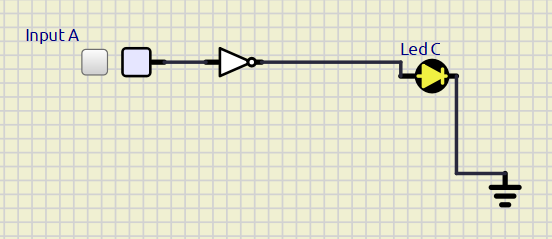
- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of NOT gate.

|  |  |
| --- | --- |
| A | Y= |
| Low | High |
| High | Low |

Implement the circuit via simulation software and paste the result in here



b. AND gate

- Two inputs of AND gate wire up to switches.

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of AND gate.

|  |  |  |
| --- | --- | --- |
| A | B | Y= AB |
| Low | Low | Low |
| Low | High | Low |
| High | Low | Low |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A diagram of a computer

Description automatically generated

c. OR gate

- Two inputs of OR gate wire up to switches.

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of OR gate.

|  |  |  |
| --- | --- | --- |
| A | B | Y= A+B |
| Low | Low | Low |
| Low | High | High |
| High | Low | High |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

d. XOR gate

- Two inputs of XOR gate wire up to switches.

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of XOR gate.

|  |  |  |
| --- | --- | --- |
| A | B | Y= AB |
| Low | Low | Low |
| Low | High | High |
| High | Low | High |
| High | High | Low |

Implement the circuit via simulation software and paste the result in here

A diagram of a light bulb

Description automatically generated with medium confidence

e. NAND gate

- Two inputs of NAND gate wire up to switches.

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of NAND gate.

|  |  |  |
| --- | --- | --- |
| A | B | Y= |
| Low | Low | High |
| Low | High | High |
| High | Low | High |
| High | High | Low |

Implement the circuit via simulation software and paste the result in here

A graph with a wire and a line

Description automatically generated with medium confidence

f. NOR gate

- Two inputs of NOR gate wire up to switches.

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of NOR gate.

|  |  |  |
| --- | --- | --- |
| A | B | Y= |
| Low | Low | High |
| Low | High | Low |
| High | Low | Low |
| High | High | Low |

Implement the circuit via simulation software and paste the result in here

A diagram of a diagram

Description automatically generated

2. Changing gate method

Using universal gate (NAND & NOR gate) to derive other logic gates

a. Using NAND to make other logic gates

- Construct the circuit for each figure 1

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of figure 1a.

- Do the same steps for figure 1b, 1c, 1d.



Figure 1a

Figure 1b

Figure 1c

Figure 1d

- Which do these circuits in figure 1a, 1b, 1c, 1d correspond with logic gates?

1a: NOT gate

1b: AND gate

1c: OR gate

1d: NOR gate

Truth table and correspond with logic gates of Figure 1b

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | Low |
| Low | High | Low |
| High | Low | Low |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A diagram of a connection

Description automatically generated

Truth table and correspond with logic gates of Figure 1c

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | Low |
| Low | High | High |
| High | Low | High |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

Truth table and correspond with logic gates of Figure 1d

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | High |
| Low | High | Low |
| High | Low | Low |
| High | High | Low |

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

b. Using NOR to make other logic gates

- Construct the circuit for each figure 2

- Output wire up to led-display

- Toggle switch to change input logic level.

- Get the results and write down the truth table of figure2a.

- Do the same steps for figure 2b, 2c, 2d.



Figure 2a

Figure 2b

Figure 2c

Figure 2d

- Which do these circuits in figure 2a, 2b, 2c, 2d correspond with logic gates?

2a: NOT gate

2b: OR gate

2c: AND gate

2d: NAND gate

Truth table and correspond with logic gates of Figure 2b

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | Low |
| Low | High | High |
| High | Low | High |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A black and white arrow with a white tip

Description automatically generated with medium confidence

Truth table and correspond with logic gates of Figure 2c

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | Low |
| Low | High | Low |
| High | Low | Low |
| High | High | High |

Implement the circuit via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

Truth table and correspond with logic gates of Figure 2d

|  |  |  |
| --- | --- | --- |
| A | B | Y (Output) |
| Low | Low | High |
| Low | High | High |
| High | Low | High |
| High | High | Low |

Implement the circuit via simulation software and paste the result in here

A diagram of a computer

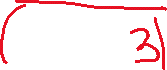
Description automatically generated

3. Design and simply the combinational logic circuit using logic gates

a. Given the circuit below, find the function

Diagram

Description automatically generated



Write down the function (((A+C)’)B)’ ⊕ C)'

Fill in the truth Table:

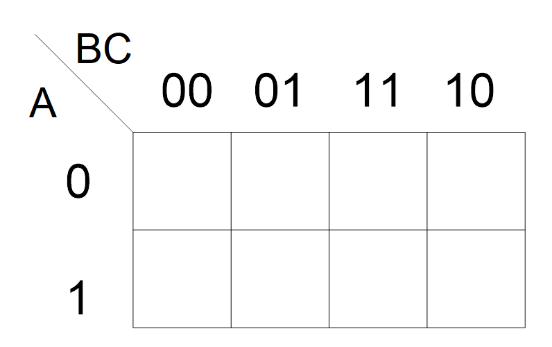
|  |  |  |  |
| --- | --- | --- | --- |
| A | B | C | F1 |
| 1 | 1 | 1 | 1 |
| 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 |

Implement the circuit via simulation software and paste the result in here

A graph paper with arrows and text

Description automatically generated

Using K-map to simplify function above





The simplified C + BA’

Implement the new expression via simulation software and paste the result in here

A diagram of a computer code

Description automatically generated

b. Given the circuit below, find the function

Diagram

Description automatically generated

Write down the function ((AB) + C’)(((AB)C)’)

Fill in the truth Table:

|  |  |  |  |
| --- | --- | --- | --- |
| A | B | C | F2 |
| 1 | 1 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 1 |

Implement the circuit via simulation software and paste the result in here

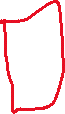
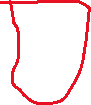
A diagram of a circuit

Description automatically generated

Using K-map to simplify function above

Calendar

Description automatically generated



The simplified B’C’ + BC’ = C’(B’ + B) = C’

Implement the new expression via simulation software and paste the result in here

A graph with a line pointing to a right arrow

Description automatically generated with medium confidence

c. Given the circuit below, find the function

Diagram

Description automatically generated

Write down the function (((AB)C)’) ⊕ (C + D)

Fill in the truth Table:

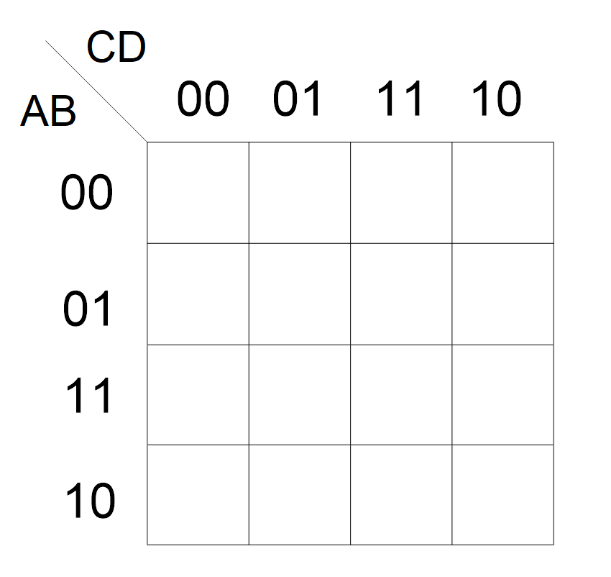
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| A | B | C | D | F3 |
| 1 | 1 | 1 | 1 | 1 |
| 1 | 1 | 1 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 0 | 0 | 1 |

Implement the circuit via simulation software and paste the result in here

A diagram of a computer

Description automatically generated

Using K-map to simplify function above





The simplified C’D’ + ABC

Implement the new expression via simulation software and paste the result in here

A diagram of a circuit

Description automatically generated

4. Design and simply the combinational logic circuit using IC logic gates

- Building the circuit from the Integrated Circuits (IC).

IC 74HC00 is quad input NAND gate and 74HC02 is quad input NOR gate

A picture containing calendar

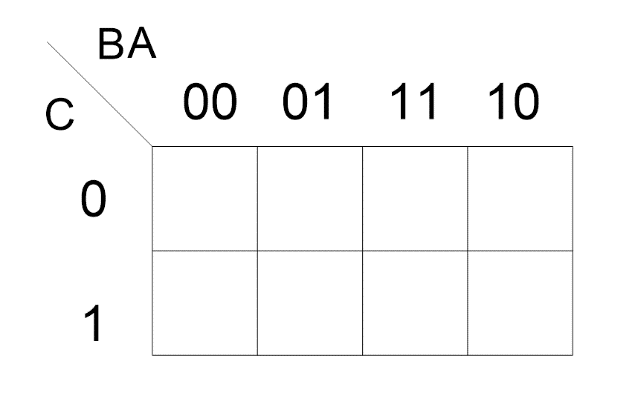
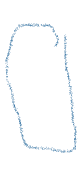
Description automatically generated A picture containing text

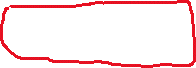
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a. Only Using NAND gates in IC 74HC00 to construct the circuit for expression

A white board with numbers and symbols

Description automatically generated





The simplified expression is A’ + B’C’

Implement the circuit via simulation software and paste the result in here

A computer diagram of a circuit board

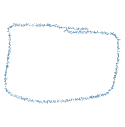
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b. Only Using NOR gates in IC 74HC02 to construct the circuit for expression

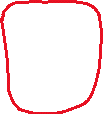
A white board with numbers and symbols

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Calendar

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The simplified expression is CB + A

Implement the circuit via simulation software and paste the result in here

A computer screen shot of a circuit

Description automatically generated

Extra Exercise

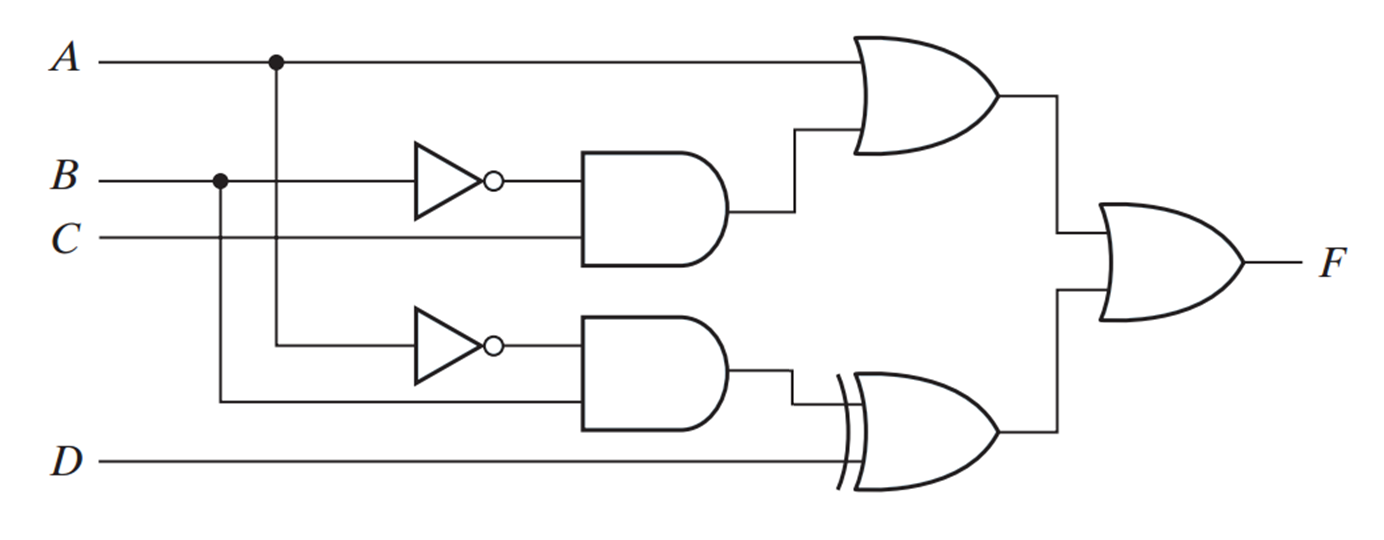
Besides the IC 74HC00 for NAND gates and 74HC02 for NOR gates, there are also IC for AND, OR, XOR gates:

+ 74HC08 quad 2-input AND gate

+ 74HC32 quad 2-input OR gate

+ 74HC86 quad 2-input XOR gate

Implement the circuit below by using the IC above in simulation software



Paste the result from simulation software in here

The expression for the circuit is

Is the expression is simplest or not? If not, provide your simplification step and implement the simplified circuit in simulation software.