
Practice 2

INTRODUCTION TO DIGITAL INTEGRATED CIRCUITS

Objectives:

The purpose of this practice is to familiarize students with the logic gates, which are the basic digital integrated circuits. The student will learn how to simplify circuits from the truth table, how an elementary adder works and how to implement a 4-bit adder using elementary ones.

Previous concepts

Before the realization of this practice the student should understand the concepts studied in theory classes about basic logic circuits, truth tables and circuit simplification methods.

Material required

The material needed (per pair) will be:

Material common to **all practices**:

Breadboard.

Flat nose pliers.

Stripper, scissors (Electrician), wire cutters or similar.

Small screwdriver.

Wire to connect components.

Specific components for **practice 2**:

Integrated Circuits: AND (7408), OR (7432), NAND (7400), XOR (7486).
(You only need one integrated circuit of each type per pair, although it would be convenient to have a replacement in case it breaks down).

Micro-switches: 1 unit of 4 elements.

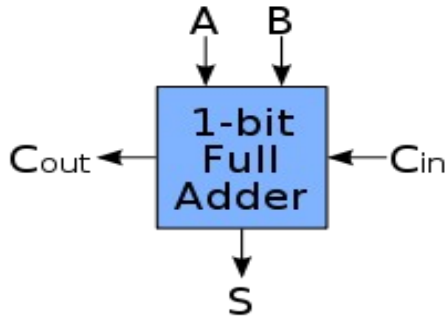
Resistors: 4 units of 1K Ω and 8 of 330 Ω .

LEDs: 2 units (any color except IR LEDs).

PART 1: Introduction to digital circuits. The elementary adder.

Duration: 2 hours

Given the truth table of an elemental adder (two bits):



Inputs			Outputs	
<i>A</i>	<i>B</i>	<i>C_{in}</i>	<i>C_{out}</i>	<i>S</i>
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

1. Express the functions *S* and *Cout* in form of Minterms.

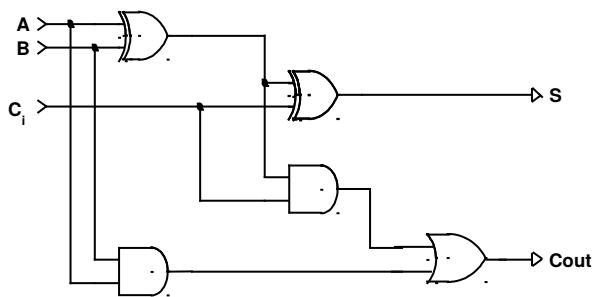
S =

Cout =

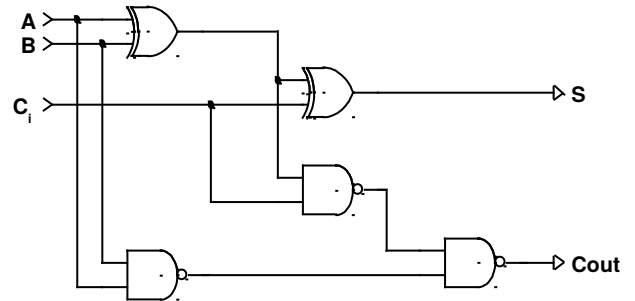
2. Simplify function *S* from the above expression using XOR function:

***S* =**

3. Simplify Cout function using Karnaugh and using Boolean algebra. Demonstrate that the Cto. 1 is equivalent to the Cto. 2:



Cto. 1



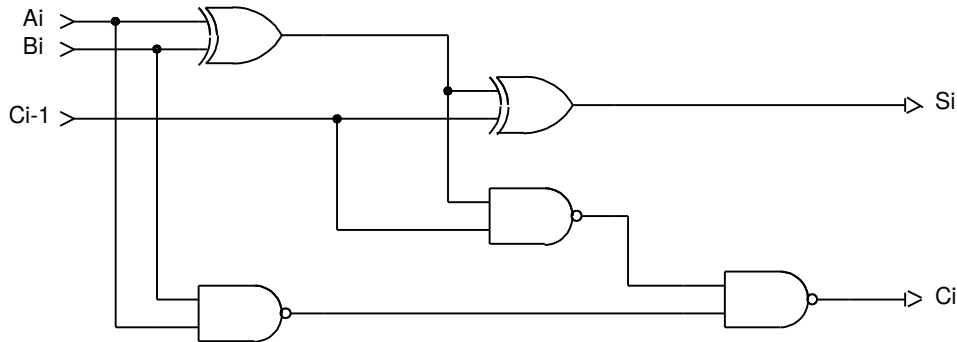
Cto. 2

4. Implement circuit 1 or circuit 2 on your board (choose only one). Enter the inputs A, B and Cin using microswitches and display the outputs S and Cout using leds. Verify that your circuit follows the truth table of an elementary adder.

When we have a 1 in the output of the circuit is the LED on or off?

PART 2: Introduction to digital circuits. The 4-bit adder with carry propagation. Duration: 2 hours

In the following figure we have an elementary 2-bit adder:



1. If each of the gates has a delay of 3ns. How long does it take to have the definitive value in the output Si and in the output Ci.

2. Using several 2-bit adders like the previous figure, design a four-bit adder with initial carry (that add two numbers of four bits each). How long it takes to the to have the final result and the final carry?

3. Using two 2-bit adders, build an adder of two-bit numbers with initial carry