German-Jordanian University
School of Electrical Engineering and Information Technology
Department of Computer Engineering

CE2120-Digital Systems Lab
Lab 2

I. Objectives

The objective of this lab is to enhance the skills of the students in designing, wiring, and testing logic circuits. In this experiment, students will design Excess-3 to BCD code converter and BCD to 8, 4, -2, -1 code converter.

II. Theory

Pre-requisite:
Please watch the following video to prepare for this lab:
https://gjuedujo.sharepoint.com/:v:/s/CE212-DigitalSystems-Section1-Summer2021/Eav8QIQoiktAh05AAc-HVBABR0SVwUMtgsmBqHExb9idFA?e=nRy0Kl

Code conversion:
The existing of different types of codes for the same discrete elements of information results in the use of different codes by different digital systems. It is sometimes necessary to use the output of one system as the input to the other. The conversion circuit must be inserted between the two systems if each uses different codes for the same information. Thus, a code converter is a circuit that makes the two systems compatible even though each of them uses a different code. In this experiment, we shall build two circuits, the first one converts from Excess-3 to BCD code, and the second one converts from BCD to 8 4 -2 -1 code.

Binary Coded Decimal (8-4-2-1 BCD) code is a numeric code that represents numeric information, i.e. only numbers as a series of 0's and 1's. In this experiment, the 8-4-2-1 BCD code represents the digits of a decimal number by encoding each digit one at a time into group of four binary digits.

8, 4, -2, -1 code is an example of assigning both positive and negative weights to a decimal code.

Excess-3 is a non-weighted code. The Excess-3 code for the decimal number is obtained in the same manner as 8-4-2-1 BCD except that decimal number 3 is added to each decimal unit before encoding it to binary.

In this experiment, we are interesting in building two converters that convert decimal digits in the range 0-9 from Excess-3 to BCD code, and the second converter from BCD to 8, 4, -2, -1 code.

III. Preparations

1. Excess-3 code to BCD code converter.

Consider the logic diagram below for Excess-3 code to BCD converter.

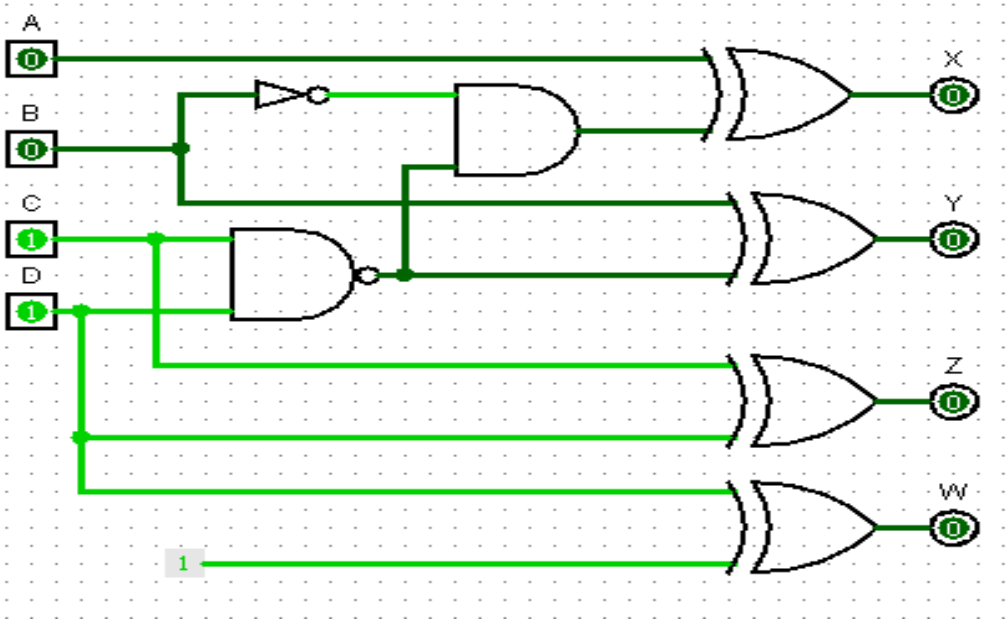

Figure 1: Excess-3 to BCD code converter

a. Fill the truth table below for the Excess-3 to BCD code converter.

Decimal Digit	Excess-3 code				BCD code			
	A	B	C	D	X	Y	Z	W
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

b. From the circuit, derive the Boolean expression that describes each output (X, Y, Z and W) in terms of the inputs (A, B, C, and D).

c. Build the circuit of each output using Logisim.

2. BCD code to 8, 4, -2, -1 code converter.

Consider the logic diagram below for BCD to 8, 4, -2,-1 code converter

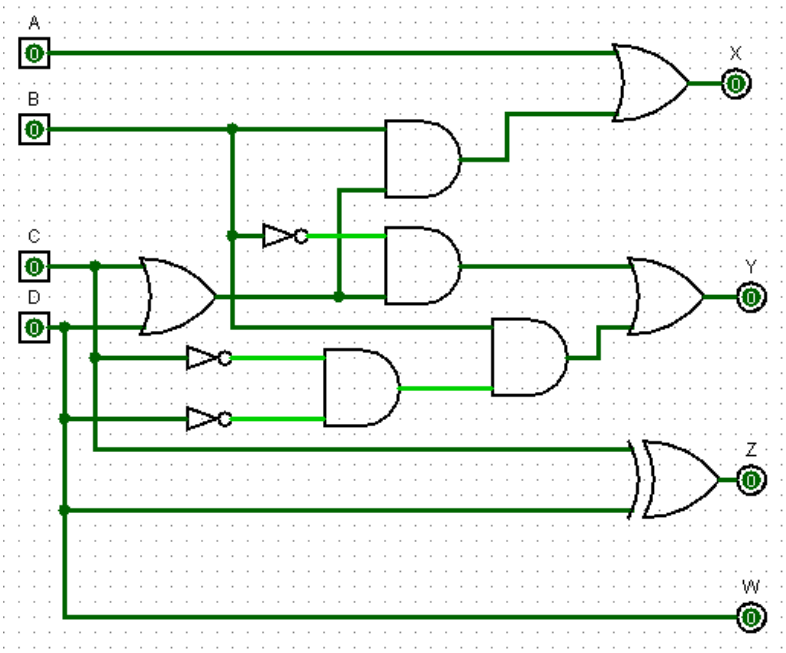

Figure 2: BCD to 8, 4, -2, -1 code converter

a. Fill the truth table for the BCD to **8, 4, -2, -1** code converter.

Decimal Digit	8, 4, 2, 1 BCD				8, 4, -2, -1 code			
	A	B	C	D	X	Y	Z	W
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								

b. From the circuit, derive the Boolean expression that describes each output (X, Y, Z and W) in terms of the inputs (A, B, C, and D).

c. Build the circuit of each output using Logisim.

IV. Lab work

In this experiment:

1. Build the circuit in Figure 1 **on the breadboard** and verify the truth table you have obtained in part1.a.

2. Build the circuit in Figure 2 **on the breadboard** and verify the truth table you have obtained in part2.a.