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

CE2120-Digital Systems Lab
Lab 5

I. Objectives

The objective of this lab is to design and build combinational logic circuits that perform several functionalities such as 9's and 2's complements. In addition, this lab will allow students to practice using Boolean algebra theorems to simplify Boolean expressions.

II. Preparations

Note 1: you need to show the details of your work in order to get the points; otherwise you will receive no credit.
Note 2: Do not use K-maps!

1. Design a combinational circuit with 3 inputs and 6 outputs. The output binary number should be the square of the input binary number.
    a. Provide the truth table for the combinational circuit.
    b. Write the Boolean expression for each output as a SOP, **and then use Boolean algebra theorems** to simplify it.
    c. Obtain logic diagram for each output.

2. Design a combinational circuit with 4 inputs that represent a decimal digit in BCD and 4 outputs that produce the 9's complement of the input digit. The six unused combinations can be treated as don't-care conditions.
    a. Provide the truth table for the combinational circuit.
    b. Write the Boolean expression for each output as a SOP, **and then use Boolean algebra theorems** to simplify it.
    c. Obtain logic diagram for each output.

3. Design a combinational circuit with 4 inputs and 4 outputs. The output generates the 2's complement of the input binary number.
    a. Provide the truth table for the combinational circuit.
    b. Write the Boolean expression for each output as a SOP, **and then use Boolean algebra theorems** to simplify it.
    c. Obtain logic diagram for each output.

4. In error detection, a parity bit is appended to a binary message to make the total number of 1's either odd or even. Design an even parity generator for a 3 bit message using XOR gates only.

a. First construct the truth table for the parity function.
b. Then, obtain an expression for the parity function by summing its minterms.
c. Using the Boolean algebra theorems you have learned in the class, simplify the parity function in part 6.b to obtain a logic circuit with only 2 input XOR gates.

A	B	C	Parity bit (F)

III. Lab work

In this experiment:

a. Setup the circuit in 1.c on your breadboard and use LEDs to check the logic level of the outputs. Also, check the operation of the circuit using the obtained truth table.

b. Setup the circuit in 3.c on your breadboard and use LEDs to check the logic level of the outputs. Also, check the operation of the circuit using the obtained truth table.

c. Build the circuit in part 4.c on your breadboard and verify the truth table you have obtained.