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

CE2120-Digital Systems Lab
Lab 8

I. Objectives

The objective of this lab is to design and build combinational logic circuits that perform several arithmetic operations. In particular, this lab combines several logic components, which have been introduced in Chapter 4 such as the multiplexers, adders, and comparators, to construct a basic arithmetic unit that performs the operations in Table 1.

II. Preparations

1. Design a 4-bit arithmetic combinational circuit that performs the operations defined in Table 1.

Table 1: Operation table of the arithmetic unit.

Control Inputs		Operation
M_1	M_0	

0	0	if(A/4==0)
		then S = A + B;
		else S = A – B;

0	1	if(A<B)
		then S = A + (B * 8);
		else S = A + (B / 4);

1	0	S = A + 4;
1	1	S = A + (B * 8) + 1;

Where:

- Both A and B are 4-bit binary unsigned numbers ($A_3\,A_2\,A_1\,A_0$) and ($B_3\,B_2\,B_1\,B_0$).
- M_1, M_0 are the control inputs to the arithmetic unit, based on the values of M_1 and M_0 the arithmetic unit performs a specific operation.
- S is the 4-bit output of the arithmetic unit ($S_3\,S_2\,S_1\,S_0$).
- B*8 is the result of performing integer multiplication of the 4-bit number B by 8.

- A/4 is the result of performing integer division of the 4-bit number A by 4.

- The design of the combinational logic circuit inside the arithmetic should employ the minimum number of the following components: invertors, 4-bit Comparator (74LS85), 4-bit binary Full adders (74LS83), 4:1 Multiplexers (74LS153), and 2:1 Multiplexers. Hint: if 2:1 multiplexers are not available, replace them with 4:1 Multiplexers.

- Although the inputs and outputs are unsigned numbers, you can use 2's complement arithmetic within the design of your circuit once needed.

- **Clearly mark the pins of any component you use by identifying its inputs, outputs and controls, and explain your solution (No credit without fully explaining the circuit).**

III. Lab work

In the lab, setup the circuits that you have constructed for the arithmetic unit on your breadboard and use the LEDs to check the logic level of the outputs.