Exercises sheet 2 (Assignment N° 2)
Adders: Half-Adder, Full-Adder.
Subtractors: Half-Subtractor, Full-Subtractor.

Exercise 01: (Just to warm-up and break the ice)

1. Give the truth table of a half adder and of a full adder.
2. Determine the logical expressions of the outputs (S: sum, C: carry) of a half adder and full adder.
1. Give the truth table of a half subtractor and of a full subtractor.
2. Determine the logical expressions of the outputs (D: difference, B: Borrow) of a half subtractor and of a full subtractor.

Exercise 02:

1- Deduce the logic circuit that implements two's (2's) complement of n bits using the definition of a half adder and a full adder seen in the lecture (course).

2- Consider the number "A" is a binary number of three bits, deduce the logic circuit which implements (A-1) using full subtractors.

Exercise 03:

Deduce the logic circuit which implements (A+1 and A-1) using full adders and a control signal "k" which, when it is 0, the circuit calculates the number A + 1, and when it is 1, changes from A to A – 1.

Remarks: We take "A" on 4 bits. Recall that (A – 1) amounts to adding to "A" the number $(1111)_2$, i.e. (A – 1 = A + 1111).

Exercise 04:

Design a circuit of an adder-subtracter using control signal "k" that holds a binary value of either 0 or 1 which determines that the operation is carried out is addition or subtraction. When the control line "k" is 0, causes the addition of A+B, and when it is 1 gives A–B.

Remarks: Recall that subtracting amounts to adding the complement of B and to add 1 (Let's consider two 4-bit binary numbers A and B as inputs).

Exercise 05:

1- Implement Full Adder using Two half adders and basic gates.

2- Implement a Full Subtractor using Two Half Subtractors and basic gates.

Exercise 06:

1- Convert a half adder into half subtractor using basic gates.

2- Convert a half subtractor into half adder using basic gates.

Exercise 07: (Optional exercise, we won't discuss in class)

1- Convert a full adder into full subtractor using basic gates.

2- Convert a full subtractor into full adder using basic gates.

3- Implement a half subtractor that calculates y-x using a half adder.

Success is not the key to happiness. Happiness is the key to success. If you love what you are doing, you will be successful.