Laboratory 2
(Due date: **002/003**: October 3rd, **004**: October 4th)

OBJECTIVES
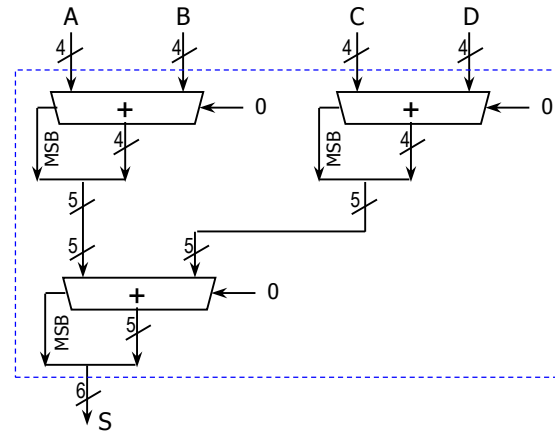✓ Use the Structural Description on VHDL.
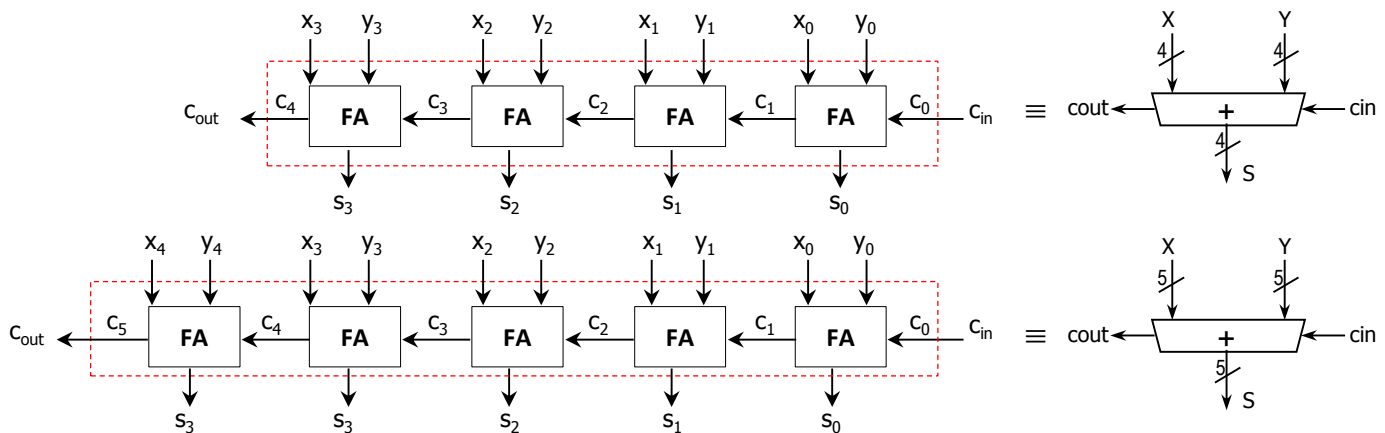✓ Test arithmetic circuits on an FPGA.

VHDL CODING
✓ Refer to the Tutorial: VHDL for FPGAs for a list of examples.

FIRST ACTIVITY (100/100)
▪ **PROBLEM**: Addition of four 4-bit unsigned numbers. The addition result requires 6 bits. This circuit can be built out of two 4-bit adders and one 5-bit adder as depicted in the figure ⇒
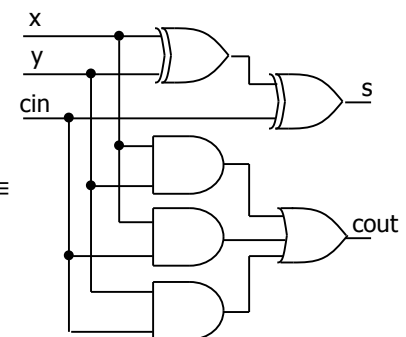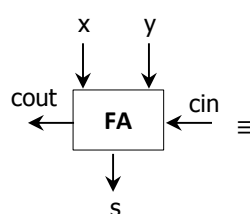

▪ The figure below depicts the internal architecture of the 4-bit adder and the 5-bit adder. The full adder circuit is also shown.

✓ Create a new ISE Project. Select the **XC7A100T-1CSG324 Artix-7 FPGA** device.
✓ Write the VHDL code for the Adder of four 4-bit unsigned numbers. Use the Structural Description: Create a separate file for the Full Adder, the 4-bit adder, the 5-bit adder, and the top file (Adder of 4 4-bit numbers).
✓ Write the VHDL testbench to test the circuit to test the following cases:
  ♦ A=0xE, B=0x8, C=0xF, D=0x9 → S=101110
  ♦ A=0xF, B=0xE, C=0x7, D=0x3 → S=100111
  ♦ A=0xA, B=0x6, C=0x4, D=0x8 → S=011100
✓ Perform Functional Simulation and Timing Simulation of your design. **Demonstrate this to your TA**.
✓ I/O Assignment: Create the UCF file. Nexys-4 DDR: Use SW0 to SW15 for the inputs, and LED5 to LED0 for the outputs.
✓ Generate and download the bitstream on the FPGA and test. **Demonstrate this to your TA**.

FULL ADDER

▪ Submit (as a .zip file) the five generated files: VHDL code (4 files), VHDL testbench, and UCF file to Moodle (an assignment will be created). DO NOT submit the whole ISE Project.

TA signature: _____   Date: _____