

ECE238

Lab Homework #3 (6 % Lab Grade)

Due Friday 14 at noon

(You can drop your homework at room 223)

Problem 1

A half adder is an arithmetic circuit that generates the sum of two binary digits. The circuit has two inputs, X and Y, and two outputs, S and C. The input variables are the augend and addend bits to be added, and the output variables produce the sum (S) and the carry (C). Write a VHDL description for a half adder using **concurrent signal assignments** only. For doing so, simplify the boolean expressions for the output lines in terms of the inputs and use the expressions directly in the assignment statements. References at page 202 of the Mano book.

A full adder takes two inputs, X and Y, and a carry-in (C_IN), and generates the sum (S) and carry-out (C). Write a VHDL description for a full-adder using only half adders previously designed and an OR gate. References at page 204 of the Mano book.

An n -bit adder can be done by cascading full adders. Design a 4-bit binary adder that uses full-adders designed above. Reference at page 205 of the Mano book.

For this problem, do the following:

1. Test the half-adder and full-adder individually. Test for all possible combinations of inputs for both designs. Turn in the VHDL code for both the designs and their testbenches. Also attach the waveforms that result.

2. Test the 4-bit adder for the following inputs:
 - a. "0000" + "0000"
 - b. "1111" + "0001"
 - c. "1010" + "0101"

Attach the VHDL code for the 4-bit adder and the testbench. Attach waveforms for the above mentioned test cases.

Problem 2

Write a VHDL description for a 4-bit by 3-bit binary multiplier. The multiplier has two inputs, B (4-bit wide) and A (3-bit wide), and an output C of 7-bit wide (see Figure 5-11, page 223, Mano book). For this design you must use the 4-bit adder designed previously.

Write a testbench for testing the following inputs:

- a. "0000" * "000"
- b. "1001" * "010"
- c. "1010" * "101"

Turn in the following:

1. Hardcopy of the VHDL code for your design and the testbench.
2. Waveforms.