CT Unit 4: Combinational Logic Circuit Design Project Group: Name:

Introduction

The purpose of the *Combinational Logic Circuits Design* project is for students to acquire basic logic design methodology and become familiar with the engineering design process. Students will be able to use truth tables or Boolean functions to design their circuits based on the given functional requirements. In addition, students will learn to use off-the-shelf tool (*Logisim*) to conduct schematic entry, logic simulation, and logic synthesis of their design.

Tasks

SpaceX™ designs, manufactures and launches advanced rockets and spacecraft. The company was founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets.

At this moment, *SpaceX*™ is the only private company with operational vehicle capable of taking significant amounts of cargo both to and from the *International Space Station*.

In order to design the next generation space vehicle for the *Mission to Mars*, we are going to involve in the design of an on-board processor module of the flight control system.

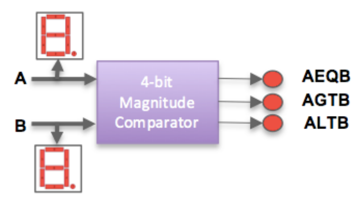
Each group will be assigned a specific subsystem, and will have to finish the following tasks on time and deliver products with quality:

1. Design the digital logic circuits based on the given functional requirements and restrictions for each subsystem.
2. Simulate the circuits using *Logicsim* and prove that the circuits are functioning correctly.

Subsystems

1. ***4-bit Binary Magnitude Comparator***:

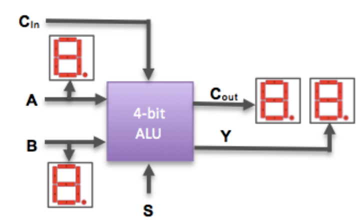
Output	Meaning
AEQB	A equal to B
AGTB	A greater than B
ALTB	A less than B



A binary magnitude comparator is a digital device that takes two binary numbers as input and determines whether one number is greater than, less than or equal to the other number. The task is to design a *4-bit Magnitude Comparator* that compares two 4-bit binary numbers. Use one *Hex Digit Display* to show the value of each operand and use one *LED* for each comparison result (*AEQB*, *AGTB* or *ALTB*). You have to build a *1-bit binary comparator* and use it as the building block to build the *4-bit binary comparator*.

2. ***4-bit Arithmetic Logic Unit (ALU)***:

S_2	S_1	S_0	Operation
0	0	0	NOT A
0	0	1	AND
0	1	0	OR
0	1	1	XOR
1	0	0	A + B
1	0	1	A + 1
1	1	0	A x 2
1	1	1	A / 2

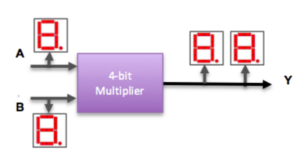


An *Arithmetic and Logic Unit* (*ALU*) is a digital circuit that performs integer arithmetic and logical operations. The *ALU* is a fundamental building block of the central processing unit of a computer.

The task is to design a *4-bit Arithmetic Logic Unit*. Use one *Hex Digit Display* to show the value of each operand. Use another *Hex Digit Displays* to show the result of logic operations.

* When $S = 7_D\ (111_B)$, the *ALU* will perform the A ÷ 2 operation. The result will be integer only, and the remainder will be discarded.

3. ***4-bit Binary Multiplier***:



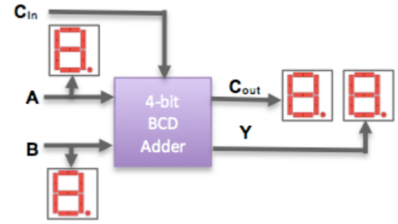
A *Binary Multiplier* is an electronic circuit used in digital electronics to multiply two binary numbers. You have to use a 2-bit binary multipliers as the building block to simplify your design. The task is to design a *4-bit Binary Multiplier* that can multiply two *4-bit binary numbers* and produce an *8-bit product*. Use one *Hex Digit Display* to show the value of each operand. Use two *Hex Digit Displays* to show the product.

4. ***Binary-Coded-Decimal (BCD) Adder***:

   In computer systems, *binary-coded decimal* (*BCD*) is a class of binary encodings of decimal numbers where each decimal digit is represented by four bits. The advantage of BCD is an ease of conversion into human-readable representations, in comparison to binary number systems. The BCD code is shown in the table.

   The task is to design a *4-bit BCD Adder*. Use one *Hex Digit Display* to show the value of each operand. Use two *Hex Digit Displays* to show the sum.

Decimal	BCD
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001



Deliverable

1. A technical report in *Microsoft Word* format including (1) problem description, (2) design methodology and process, (3) logic circuits diagram (from *Logicsim*), and (4) simulation results.
2. *Logicsim* Project file (.circ).
3. Project groups should be ready to demonstrate their logic circuits design and simulation to the class.