UCSD CSE140L Fall 2013

LAB#1

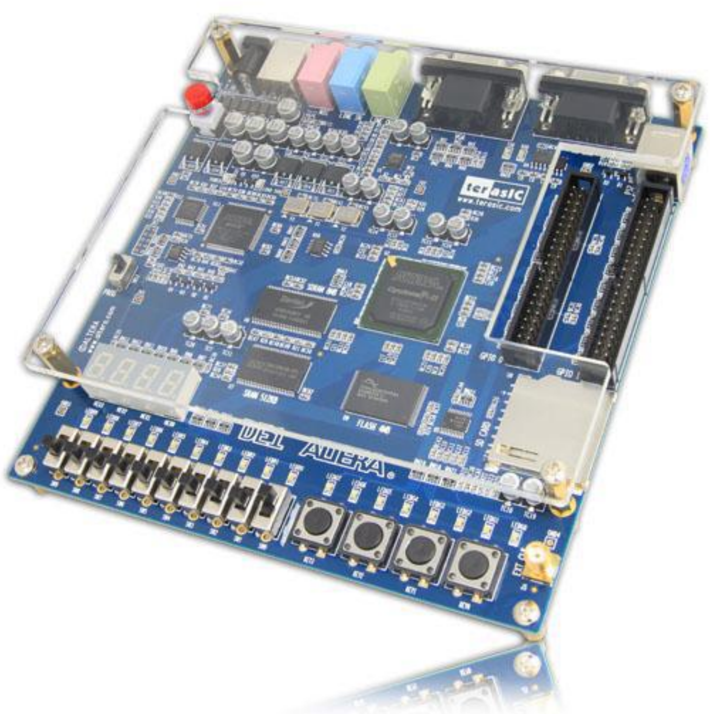
(Due Date & Time: See course web page)

Instructor: Dr. Choon Kim

Objective

- Learn and become familiar with Altera's **Quartus II CAD SW** & **DE1 Cyclone II FPGA Board**

- Learn how to design, simulate, synthesize, program on FPGA and test **basic combinational digital components** using Schematic design, Altera Quartus II CAD SW and DE1 FPGA board.



Instructions

1. Your LAB#1 project name should be L1Cyyy, where yyy=your CID(e.g., L1C079 if your CID=079).

2. A golden solution .pof and .sof files are provided to you. You need to play with them as a reference during design whenever you have a question. Remember the following rules when using the golden solution.

Each Part of the LAB specifies most **input conditions** for your design. However, it is possible that not all the possible input conditions are specified.

1) For specified **input conditions**, your design must behavior exactly same as the golden solution.
2) For other **input conditions** which were NOT specified, your design does NOT have to behavior same as the solution provided. Your design is allowed to behavior anyway you want.

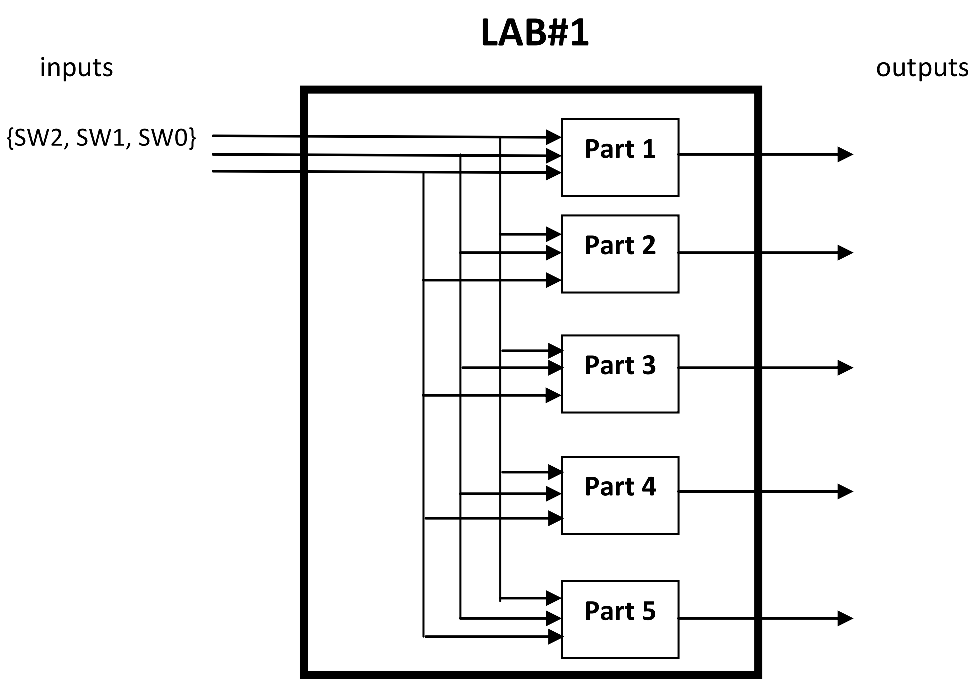
Example:

Suppose a Part specifies "If SW0 is up, turn LED0 on." and no further specifications. In this case, your design must behavior as follows.

IF SW0=up /* i.e., specified input condition */
LED0=on. /* LED0 must be same as golden solution ==> will be tested during Demo*/

IF SW0=down /* i.e., NOT specified condition(s) ==> will not be tested during Demo */
LED0= can be either on or off /* regardless of golden solution */

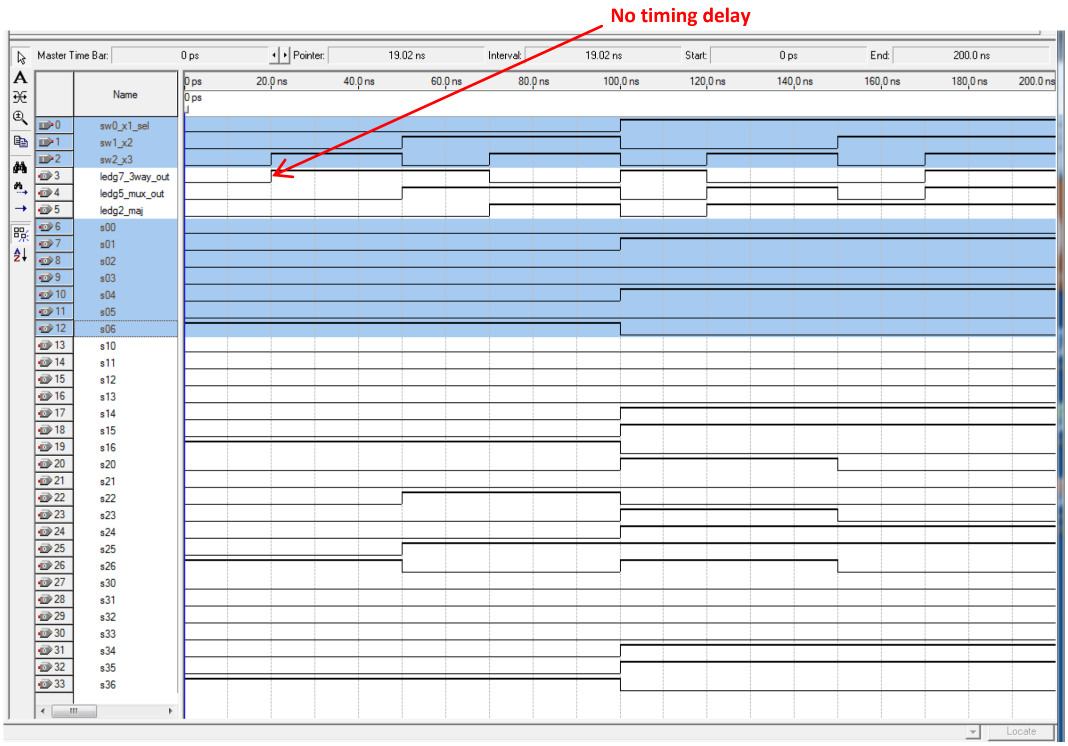
3. Use schematic design. The LAB#1 consists of five(5) Parts, Part 1 - 5. Each Part uses some or all of switches, {SW2, SW1, SW0}. Each Part has different output. See the following diagram as a reference.
Note: Part1 is a prerequisite for other Parts. You will get zero(0) point for LAB#1 if Part1 fails.



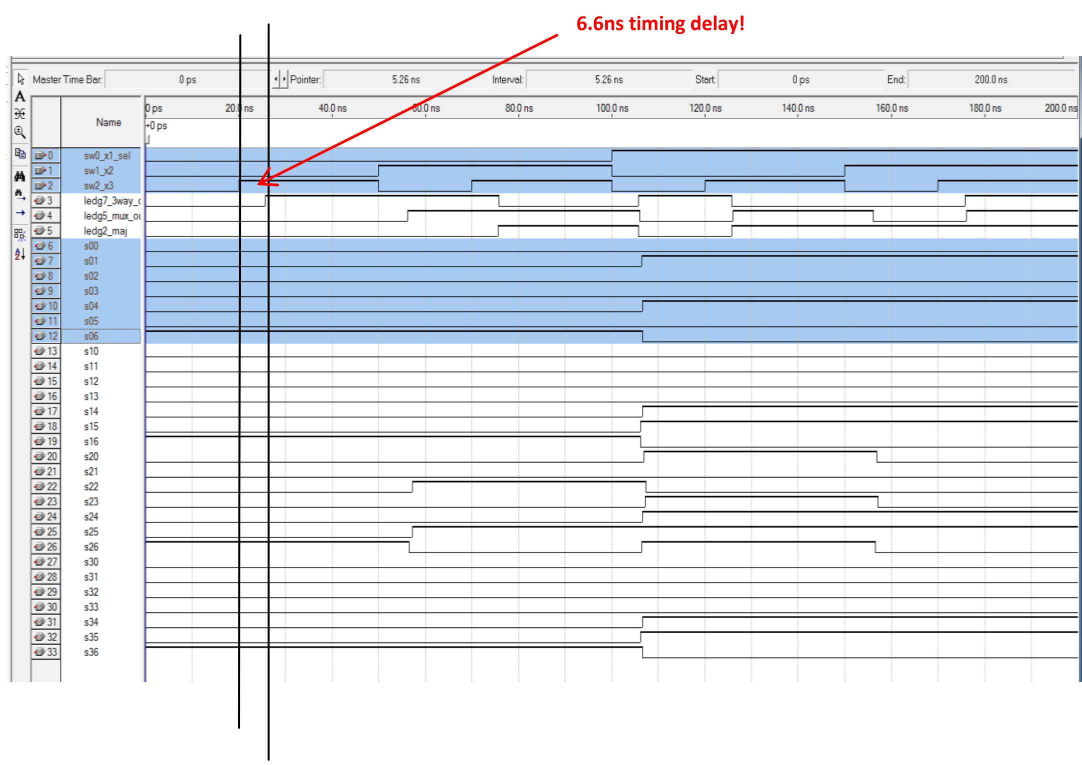
4. You should set **tpd** for LAB#1 as **8ns**
Hint: You can set this by going to Assignment->Timing Analysis Setting-> Classic Timing Analyzer, and set it there.

5. Following diagrams are example purpose only, NOT your solution.

An example **functional** simulation waveform may be similar to following diagram



An example **timing** simulation waveform may be similar to following diagram



Part 1

YOUR CLASS ID(CID) DISPLAY CIRCUIT DESIGN

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(Note: Part1 is a prerequisite for all other Parts. You will get zero(0) point for LAB#1 if Part1 fails.)

A CID display circuit takes a switch(SW) input and displays your CID on 3-digit 7-segment displays, {HEX3 HEX2 HEX1}.
Design a CID Display circuit as follows.

Inputs: **SW0**
Output: **HEX3, HEX2, HEX1** // HEX0 is not used in Part1
Operation:
if **SW0** = 0(i.e., down) **HEX3 HEX2 HEX1** displays "000".
if **SW0** = 1(i.e., up) **HEX3 HEX2 HEX1** displays your CID in 3-digit form.

Ref: The golden solution displays "**353**"(since it's CID was set to 353 -- CID no student will use).

******************* The End of Part1 **********************************

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For example, if your CID is 035, the output should be "035" displayed as follows.

Suppose your class ID is 7, then the output should be "007".
If your class ID is 247, then the output should be "247".

Study DE1 User manual sec. 4.3. for 7-segment display operation carefully. It will help you a lot.

Part 2

3-WAY LIGHT CONTROLLER CIRCUIT DESIGN

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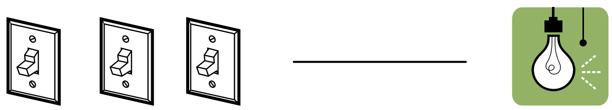
An N-way light controller circuit changes the state of the output light (ON/OFF) whenever one input switch among N input switches changes position independent of other input switches. It is a very useful circuit for light control and is used widely in houses, buildings and many other places. Your house most likely has one at least.

Design a 3-way light controller circuit as follows.



Inputs: **SW2, SW1, SW0**

Output: **LEDR1**

Initial condition: **LEDR1** is **OFF** when **SW2=SW1=SW0=0**(i.e., all down position)

Truth Table:

SW2	SW1	SW0	LEDR1	
0	0	0(=Down)	0(=OFF)	<--- Initial condition
0	0	1(=Up)	1(=ON)	
0	1	0	1	
0	1	1	0	
1	0	0	1	
1	0	1	0	
1	1	0	0	
1	1	1	1	

***************** **The End of Part2** ********************************

Part 3

2-TO-1 MUX DESIGN

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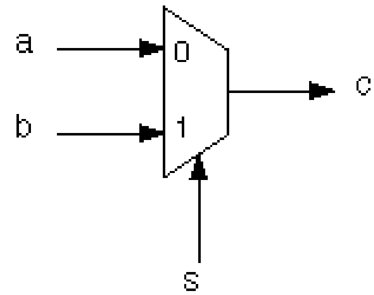

An N-to-1 multiplexor(often referred to as "mux") takes N inputs and determines an output by selector. For example above 2-to-1 mux takes inputs **a** and **b** with selector **s**. The output **c** is determined by selector's value as follows.

if s = 0 c = a
else(i.e., s = 1) c = b

Design a 2-to-1 MUX circuit as follows.

Inputs: **SW2, SW1, SW0**(=selector)
Output: **LEDR4**
Operation:

if **SW0** = 0 **LEDR4** = **SW1**
else(i.e., if **SW0** = 1) **LEDR4** = **SW2**

***************** The End of Part3 ********************************

Part 4

3-INPUT MAJORITY DETECTOR DESIGN

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A majority detector takes odd number of inputs, detects the majority of them, and make it output. If input contains more 1s than 0s, then output is 1. Otherwise output is 0.

Design a 3-input majority detector as follows.

Inputs: **SW2, SW1, SW0**
Output: **LEDR8**
Operation:

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    if the majority is 1
        LEDR8 = ON
    else    // i.e., the majority is 0
        LEDR8 = OFF
```

***************** **The End of Part4** ********************************

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For example,

if the input = 111 => the majority is 1 => **LEDR8** = ON
if the input = 101 => the majority is 1 => **LEDR8** = ON
..
..
if the input = 010 => the majority is 0 => **LEDR8** = OFF
if the input = 000 => the majority is 0 => **LEDR8** = OFF

Part 5

BINARY-TO-DECIMAL DISPLAY DESIGN

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A <u>Binary-to-Decimal Display</u> circuit converts a binary number to a decimal number and displays it on 7-segment **HEX0** display. For example, if **SW1 SW0** = "11"(in binary), then '3' is displayed on **HEX0**.

Design a <u>Binary-to-Decimal Display</u> circuit as follows.

Inputs: **SW1, SW0**(in binary) where, SW0 is LSB(Least Significant Bit)
Output: **HEX0** (in decimal)

Operation:

HEX0 displays the decimal value of **SW1 SW0**(binary number). Your design should meet the following specifications.

if **SW1 SW0** = 00 then '0' is displayed on **HEX0**
if **SW1 SW0** = 01 then '1' is displayed on **HEX0**
if **SW1 SW0** = 10 then '2' is displayed on **HEX0**
if **SW1 SW0** = 11 then '3' is displayed on **HEX0**

For example, if **SW1 SW0** = 11, **HEX0** should be

***************** **The End of Part5** *******************************