Student ID: ____________

CS 151
Quiz 4

Name : __________________ , __________________
(Last Name) (First Name)

Student ID : _______________

Signature : ________________

Instructions:

1. Please verify that your paper contains **10 pages** including this cover.
2. Write down your Student-Id on the top of each page of this quiz.
3. This exam is **closed book**. No notes or other materials are permitted.
4. Total credits of this quiz are **60 points.**
5. To receive credit you must show your work clearly.
6. **No re-grades will be entertained if you use a pencil.**
7. Calculators are **NOT** allowed.

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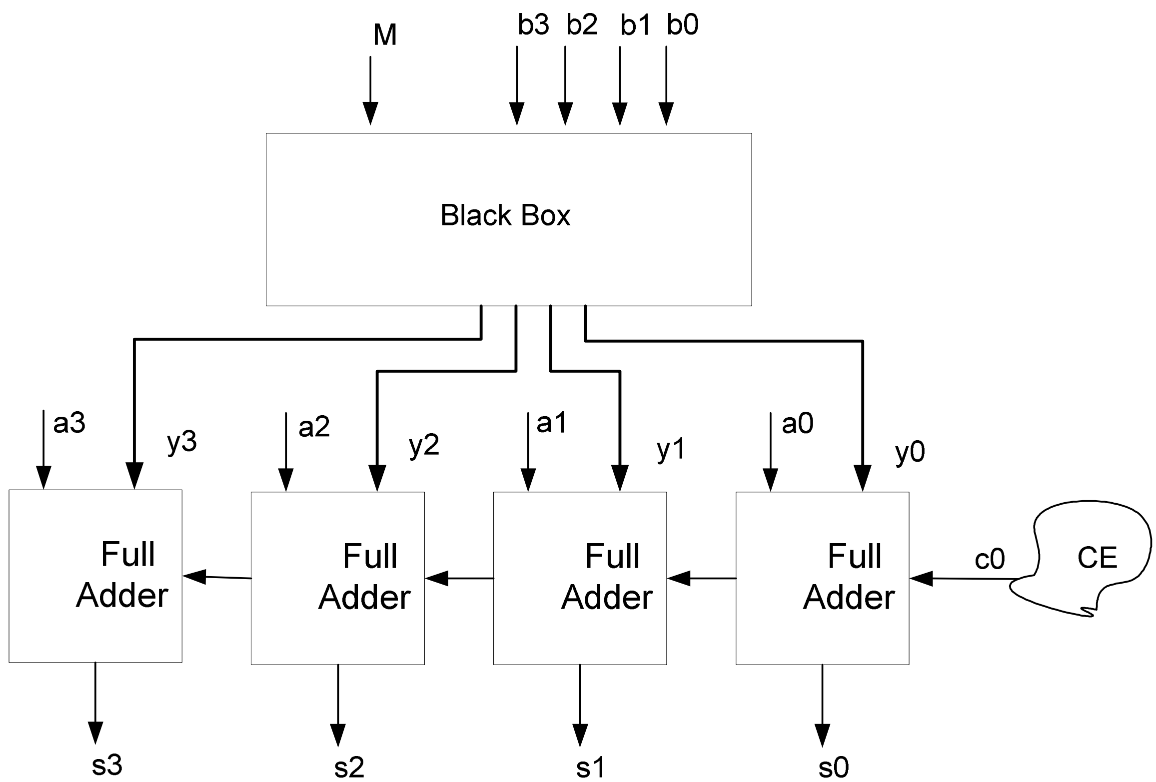
Q1: [ALU] [10 points]

We are going to design a very simple 4-bit Arithmetic Unit (AU) with the following functional table:

M	Function Name	F(A,B)
0	Subtract B from A	A-B
1	Subtract 1 from A	A-1

A and B are two, 4-bit binary numbers $a_3a_2a_1a_0$ and $b_3b_2b_1b_0$.
M is the control input to this AU.

For doing this, the blocks labeled AE (Arithmetic Extender) and CE (Carry Extender) in the following block diagram should be designed:



a. **Fill the following table for y3, y2, y1, y0 and c0 based on the inputs of the AU which are a3,a2,a1,a0, b3,b2,b1,b0, M1 and M0: [7 points]**

M	y3	y2	y1	y0	c0
0					
1					

b. Using the table that you derived in part (a), derive the logic equations for y1, y0 and c0. **[3 points]**

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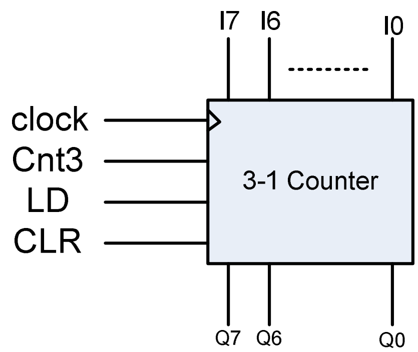
Q2: RTL design [35 points]

We want to design an 8-bit, 3-1 counter using RTL design method. The 8-bit, 3-1 counter has following block diagram and characteristics:



a. **"Cnt3" input: when Cnt3=1, it adds 3 to the current value, when Cnt3=0 it adds 1 to the current value**

b. **"LD" input: when LD=1, it loads from input I[7:0] regardless of the value of Cnt3**

c. **"CLR" input: when CLR=1, it clear the outputs (Q[7:0] = "00000000") regardless of the value of LD or Cnt3**

1. Draw the Function Table. [5 points]

2. Capture a high-level state machine [10 points]

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3. Create the datapath (Hint: use a register, and an adder to do both increment) [10 points]

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4. Connect the datapath to controller [5 points]

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5. Derive the controller's FSM [5 points]

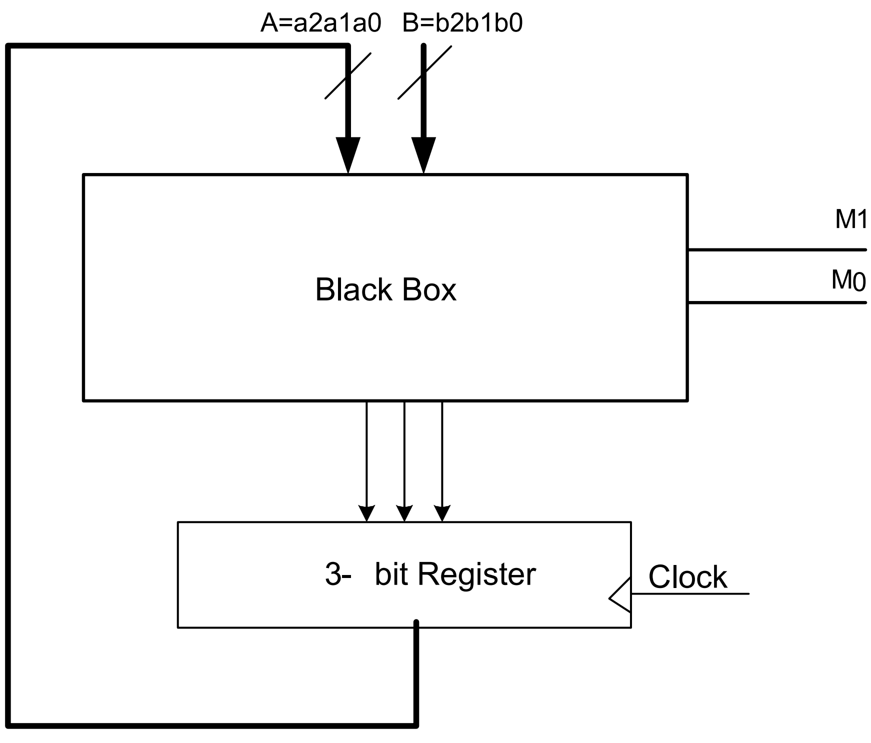
Q2: [Shift Register] [15 points]

We want to design a 3-bit circular shift register by adding the circuit in the Black Box to a 3-bit register. By just using 4-to-1 Multiplexers design the Black Box in the figure.

M1M0 are control bits to this Circular Shift Register.
The value on load line is B= $b_2b_1b_0$.

Function Table:

M1	M0	Action	Register Current Value	Register Next Value
0	0	Keep current value	A=$a_2a_1a_0$	$a_2a_1a_0$
0	1	Rotate Shift Right by 1 bit	$a_2a_1a_0$	$a_0a_2a_1$
1	0	Load	$a_2a_1a_0$	$b_2b_1b_0$
1	1	Rotate Shift Right by 2 bits	$a_2a_1a_0$	$a_1a_0a_2$



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