Computer Logic Design

Part II (Subjective): Final, Fall 2015

Time: 2.5 Hrs **Marks: 70** **Roll No: _____**

Note:

- *Attempt all the questions on **this** answer booklet. **You can do your scratch work on rough sheets but they will not be collected and marked.***
- *Make sure you write your roll # on EVERY sheet of the booklet.*
- ***Questions during exam are not allowed. Take reasonable assumptions where needed.***

Question 1: [10 Marks]

A sequential machine takes a binary sequence (one bit per cycle) as input and gives **Y** as output. Y= 1 if sequence of the input (received at any moment) forms a binary string with even no. of zeros **and** the last bit received is 1. **Draw State Diagram of this machine.**

For example:

If sequence of input is **100001,** output should be **1**. (No. of 0's are even and last bit is 1)
If sequence of input is **1,** output should be **1**. (No. of 0's are even and last bit is 1)
If sequence of input is **1111,** output should be **1**. (No. of 0's are even and last bit is 1)
If sequence of input is **100,** output should be **0**. (Last bit is not 1)
If sequence of input is **000111,** output should be **0**. (No. of Zero's are odd)

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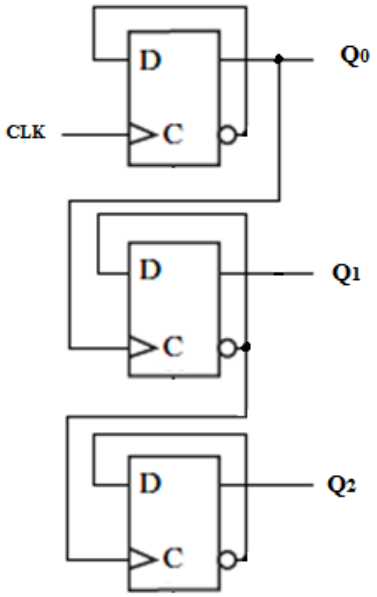
Question 2: [10 Marks]

An asynchronous circuit design is given below. Write the sequence of consecutive 5 states (3-bit values stored in 5 clock ticks going from T_1 to T_5) which this asynchronous circuit is going to transition through. Initial values stored in **Q_2 Q_1 Q_0** are **000**. Note that all the Flip-Flops are **positive edge triggered D** Flip-Flops.

Clock Ticks	Q_2	Q_1	Q_0
T_0	**0**	**0**	**0**
T_1			
T_2			
T_3			
T_4			
T_5			



Question 3(a): [4 Marks]

Characteristic table of X-Y Flip-Flop is given below. Fill in the excitation table of X-Y Flip-Flip.

Characteristic Table:

X	Y	Q(t+1)
0	0	0
0	1	Q(t)
1	0	Q(t)'
1	1	1

Excitation Table:

Q(t)	Q(t+1)	X	Y
0	0		
0	1		
1	0		
1	1		

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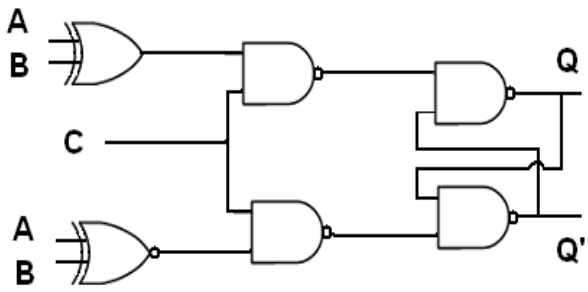
Question 3(b): [8 Marks]

A-B Latch with control input C is shown below. Assume C=1, Fill in the characteristic table for A-B Latch:

Characteristic Table:

Q(t)	A	B	Q(t+1)
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	



Question 3(c): [8 Marks]

From Part b, derive the simplified characteristic equation Q(t+1) as a function of Q(t), A, and B using K-map:

Q(t) \ AB	00	01	11	10
0				
1				

Q(t+1) = _____

Important Note for Question 4 and 5

- Assume that you already have Decoder(s), Encoder(s), MUX(s), DMUX(s), Adder-Subtractors(s), Register(s) and Counter(s) blocks available. **You do not need to implement detailed design of any of already given blocks.**
- You have to implement detailed logic diagram of any other block you are using in your circuit.
- **Properly show the flow of data and label all blocks and inputs/outputs to get credit.**

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Question 4: [2.5x4 = 10 Marks]

Make circuit design of a mini calculator which takes an opcode and two 8-bit numbers A and B as input and produces 8-bit result R as output. Operations performed by the calculator are given in table.

Opcode	Operation
00	R = A + B
01	R = A – (4*B)
10	R = A % 4
11	R = (A%16)+B

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Question 5: [20 Marks]

The FunBrain Magician is game that randomly picks a 5-bit secret number. User guesses what number it is. If the guess is high or low, FunBrain gives a hint.

FunBrain Magician performs following functionalities:

1- If user sets input GRN = 1, magician loads new random number and restarts the game. Assume you are already given a random number generator block which outputs a 5-bit random number $R_4R_3R_2R_1R_0$. **[2 Marks]**
2- Magician will accept the guessed number $G_4G_3G_2G_1G_0$ from user after every 4 clock cycles e.g. if user enters a guess after every tick magician forwards only the guesses entered at T_0, T_4, T_8, T_{12} and so on. **[4 Marks]**
3- If the answer is correct i.e. all the bits of $G_4…G_0$ and $R_4…R_0$ match CA (Correct Answer) will be set to 1. **[4 Marks]**
4- If answer is not correct but more than two bits match, H (High) will be set e.g. if R=**1**01**10** and G = **1**10**10** then H will be 1 because three bits match so guess is high. **[6 Marks]**
5- Otherwise L (Low) will be set. **[2 Marks]**
6- In the end (when CA=1) magician should tell in how many turns user is able to guess the correct number. **[2 Marks]**

Your task is to design the circuit of FunBrain Magician.

Inputs:

Clock Pulse CP
Generate Random number GRN
Guessed Number $G_4G_3G_2G_1G_0$

Output:

Correct Answer CA
Number of guesses $D_4D_3D_2D_1D_0$
High H
Low L

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FunBrain Magician