NAZARBAYEV UNIVERSITY
SCHOOL OF SCIENCE AND TECHNOLOGY

NAME. "Solution" Quiz #3 .....

EXAMINATION RULES

- The duration of this exam is 40 minutes.
- The exam consists of **8** pages including this one. Write your name to each page.
- The total points are **100**.
- Students are required to follow all instructions given by the examiners.
- Talking is NOT allowed under any circumstances.
- Students MAY NOT bring any written or printed materials into the examination room except where explicitly allowed by the examiner.
- Mobile phones are strictly prohibited in the examination room.
- Students MAY NOT bring any electronic device into the examination room except where explicitly allowed by the examiner (e.g., calculators with specified capabilities).
- Students may raise their hand to ask the examiner a question. The examiner may decide not to answer the question: students are expected to know the requisite terminology and understand the examination questions.
- For examinations lasting two hours or less, students are NOT allowed to leave the examination room until ready to turn in their work.
- Once a student has seen the examination paper, the student is assumed to be in good health at the time of the examination.

I have read and understood the examination rules. I will not cheat, copy from other students, or use unauthorized materials or devices, and I have not brought such materials or devices into the examination room.

Signed: .....

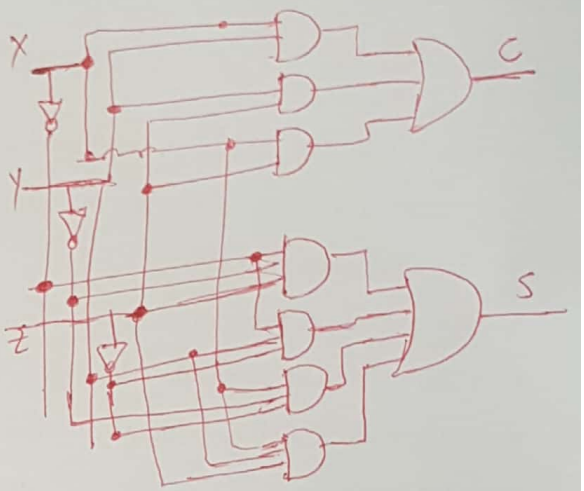
Student Name:

ROBT 206 – Microcontrollers with Laboratory Quiz #3 29 March, 2018

Answer ALL the problems. Please provide precise and neat answers.

1. Design a 1-bit width binary full adder with three inputs (**X**, **Y** and **Z**: carry in) and two outputs (**C**: Carry out and **S**: Sum). Form and fill a truth table, use K-Map to find optimal expressions for the outputs and implement it. (**20 points: 10 points for truth table, 5 points for expressions and 5 points for the implementation**)

X	Y	Z	C	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1



C

X \ YZ	00	01	11	10
0	0	0	1	0
1	0	1	1	1

S

X \ YZ	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$C = yz + xy + xz$

$S = \bar{x}\bar{y}z + \bar{x}y\bar{z} + x\bar{y}\bar{z} + xyz$

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2. Find the result of the following subtraction in binary using the 2's complement method (**20 points**)

a) $(-6)_{10}-(+24)_{10}$

- Working with signed numbers, the MSB will be the sign bit. To cover 24 and 6 we would need to have 5 more bits. => $(-6)_{10} = (000110)_2' = (111010)_2$

$(+24)_{10} = (011000)_2$

$111010 - 011000 \Rightarrow 111010 + (011000)' \Rightarrow$ ① 11 / 111010 + 100111 $\Rightarrow$ ignore the carry

$100010 \Rightarrow$ Negative number

$(100010)_2 = -(100010)_2' = -(011110)_2 = -(30)_{10}$

b) $(-3)_{10} - (-12)_{10}$

Similar to part a) $\Rightarrow$ - MSB for sign; - Four more bits to cover 12 and 3 $\Rightarrow$ 5 bits in total

$(-3)_{10} = (00011)_2' = (11101)_2$

$(-12)_{10} = (01100)_2' = (10100)_2$

$\Rightarrow 11101 - 10100 \equiv 11101 + (10100)' \equiv$ ① 11 / 11101 + 01100 / 01001 ignore the carry

the actual result is $(01001)_2 = +(9)_{10}$

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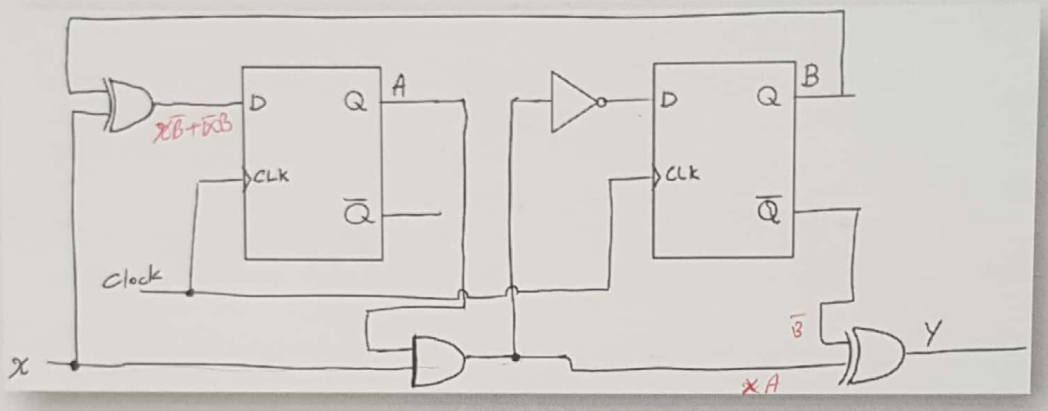
3. For the sequential circuit given below, derive the state table, draw the state diagram and find the expressions for the next state and output. Is it a Mealy or a Moore machine (Explain the reason)? (**30 points: 10 points for State table, 10 points for state diagram, 5 points for finding expressions, 5 points for Mealy-Moore categorization**)



Current State A(t)	Current State B(t)	x(t)	Next State A(t+1)	Next State B(t+1)	Output y(t)
0	0	0	0	1	1
0	0	1	1	1	1
0	1	0	1	1	0
0	1	1	0	1	0
1	0	0	0	1	1
1	0	1	1	0	0
1	1	0	1	1	0
1	1	1	0	0	1

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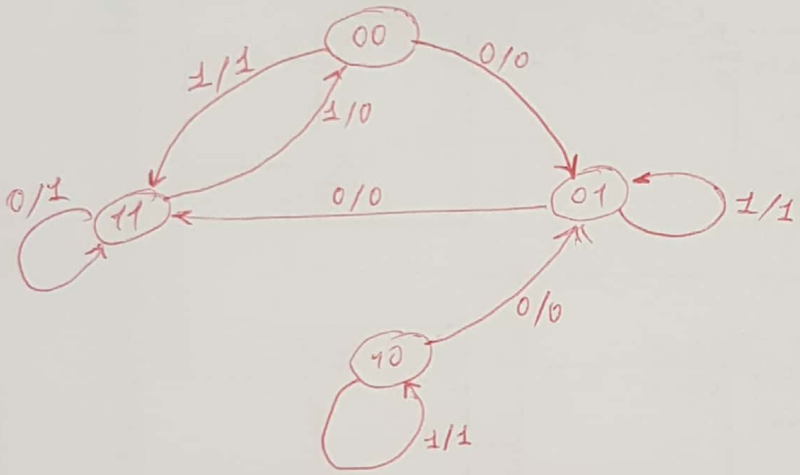
Answer ALL the problems. Please provide precise and neat answers.

State diagram:



$A(t+1) = B(t) \oplus x(t)$

$B(t+1) = \overline{A(t) \cdot x(t)}$

$y(t) = (x(t) A(t)) \oplus \overline{B}(t)$

It is a Mealy machine, as the outputs depends on State & input.

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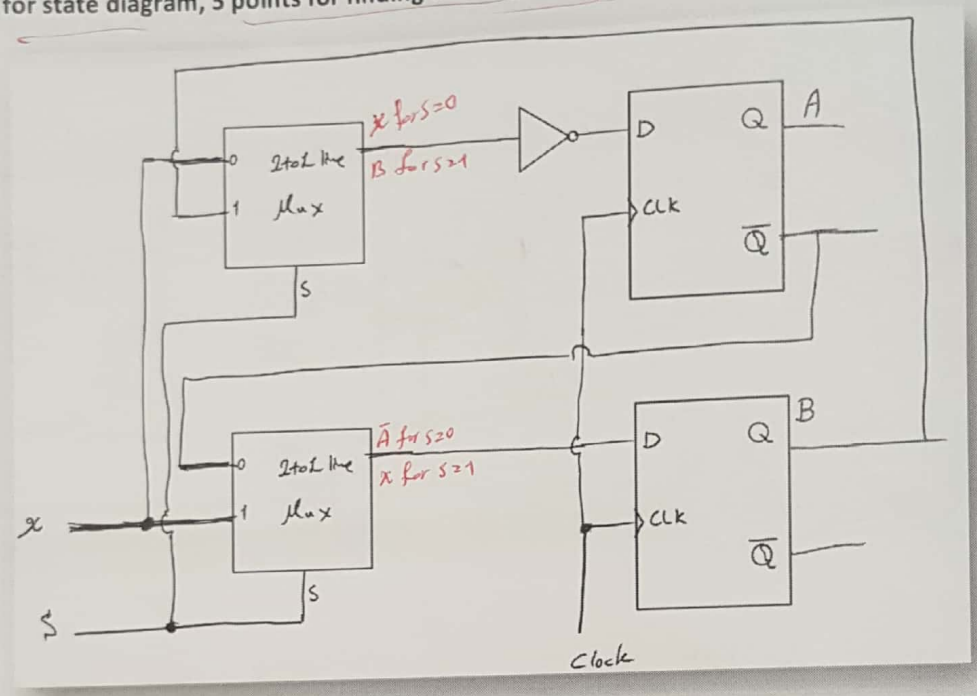
4. For the sequential circuit given below, derive the state table, draw the state diagram, find the expressions for next states, and re-implement it without using multiplexers. (**30 points: 10 points for State table, 10 points for state diagram, 5 points for finding the expressions and 5 points for implementation**)



State Table

Current State		Inputs		Next State	
A(t)	B(t)	x	S	A(t+1)	B(t+1)
0	0	0	0	$\bar{x}=1$	$\bar{A}=1$
0	0	0	1	$\bar{B}=1$	$x=0$
0	0	1	0	$\bar{x}=0$	$\bar{A}=1$
0	0	1	1	$\bar{B}=1$	$x=1$
0	1	0	0	$\bar{x}=1$	$\bar{A}=1$
0	1	0	1	$\bar{B}=0$	$x=0$
0	1	1	0	$\bar{x}=0$	$\bar{A}=1$
0	1	1	1	$\bar{B}=0$	$x=1$
1	0	0	0	$\bar{x}=1$	$\bar{A}=0$
1	0	0	1	$\bar{B}=1$	$x=0$
1	0	1	0	$\bar{x}=0$	$\bar{A}=0$
1	0	1	1	$\bar{B}=1$	$x=1$
1	1	0	0	$\bar{x}=1$ 6	$\bar{A}=0$
1	1	0	1	$\bar{B}=0$	$x=0$
1	1	1	0	$\bar{x}=0$	$\bar{A}=0$
1	1	1	1	$\bar{B}=0$	$x=1$

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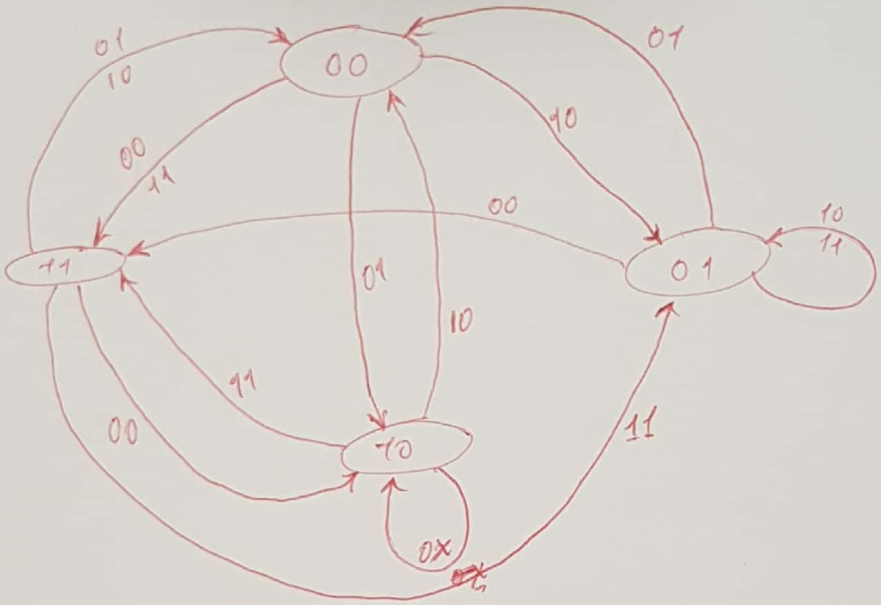
State diagram



$A(t+1) = D_A(t) = \bar{x}\bar{s} + \bar{B}s$

$B(t+1) = D_B(t) = \bar{A}(t)\cdot\bar{s} + x\cdot s$

DA

AB \ XS	00	01	11	10
00	1	1	1	0
01	1	0	0	0
11	1	0	0	0
10	1	1	1	0

DB

AB \ XS	00	01	11	10
00	1	0	1	1
01	1	0	1	1
11	0	0	1	0
10	0	0	1	0