HACETTEPE UNIVERSITY
DEPARTMENT OF COMPUTER ENGINEERING
BBM231 LOGIC DESIGN

Homework 4 (For all sections)

Assigned : 12.12.2018
Due : 17.12.2018

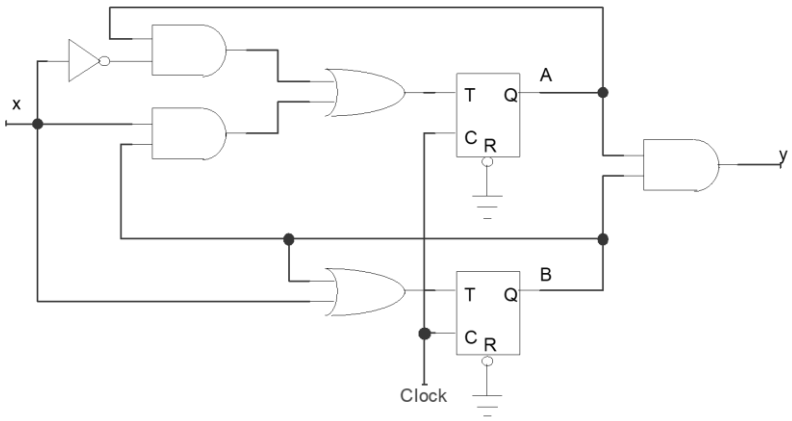
QUESTIONS:

Q1. For the sequential circuit given at right, find:

a. Input equations and state table.

b. State equations and output equation.

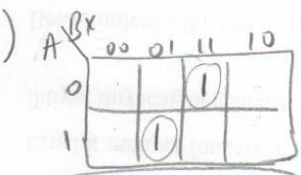
c. State diagram.



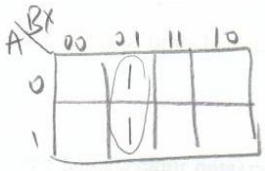
a) $T_A = Ax' + Bx$, $T_B = B + x$

A	B	x	A*	B*	y	T_A	T_B
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1
0	1	0	0	0	0	0	1
0	1	1	1	0	0	1	1
1	0	0	0	0	0	1	0
1	0	1	1	1	0	0	1
1	1	0	0	0	1	1	1
1	1	1	0	0	1	1	1

b)



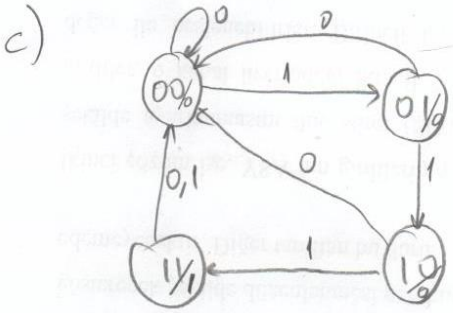
$A^* = A'Bx + AB'x$
$= x(A \oplus B)$



$B^* = B'x$

$y = AB$

c)

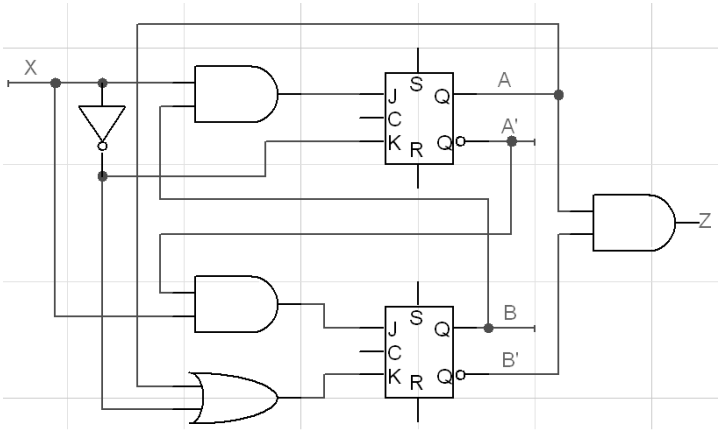


Q2. For the sequential circuit below:

a. Find flip-flop input equations (J_A, K_A, J_B, K_B) and fill the state table.

b. Write state equations and output equation.

c. Draw its state diagram.



A4

a) $J_A = X \cdot B$

$K_A = X'$

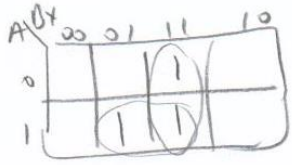
$J_B = A'X$

$K_B = A + X'$

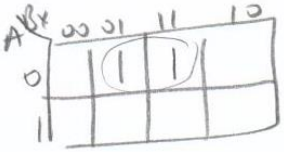
$Z = AB'$

A	B	X	A^*	B^*	Z	J_A	K_A	J_B	K_B
0	0	0	0	0	0	0	1	0	1
0	0	1	0	1	0	0	0	1	0
0	1	0	0	0	0	0	1	0	1
0	1	1	1	1	0	1	0	1	0
1	0	0	0	0	1	0	1	0	1
1	0	1	1	0	1	0	0	0	1
1	1	0	0	0	0	0	1	0	1
1	1	1	1	0	0	1	0	0	1

b)



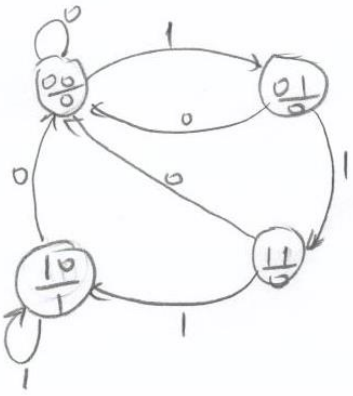
$A^* = AX + BX$



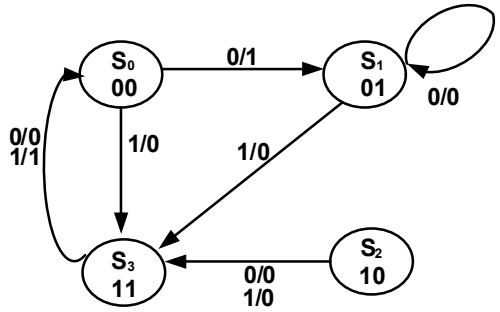
$B^* = A'X$

$Z = AB'$

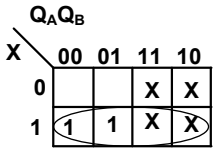
c)



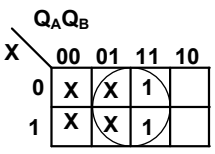
Q3. A Mealy type state diagram is given in the figure below. Using JK type flip-flops and gates, design and draw the circuit for this sequential system. (*In the diagram X(input) / Y(output)*)



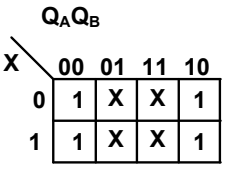
Q_AQ_BX	Q_A+	Q_B+	J_A	K_A	J_B	K_B	Z
000	0	1	0	x	1	x	1
001	1	1	1	x	1	x	0
010	0	1	0	x	x	0	0
011	1	1	1	x	x	0	0
100	1	1	x	0	1	x	0
101	1	1	x	0	1	x	0
110	0	0	x	1	x	1	0
111	0	0	x	1	x	1	1



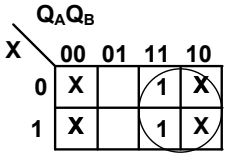
$J_A=X$



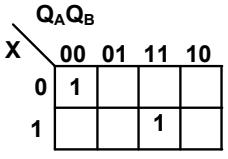
$K_A=Q_B$



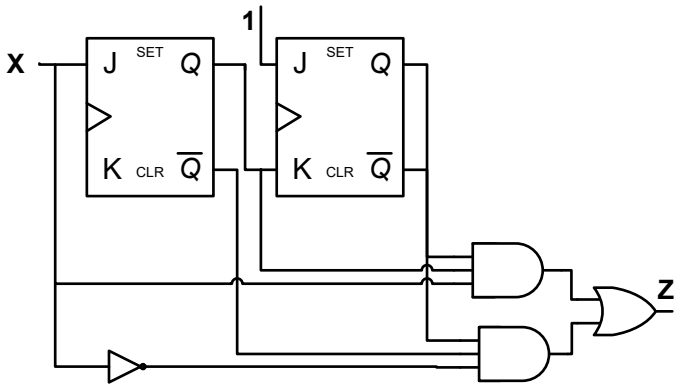
$J_B=1$



$K_B=Q_A$



$Z=Q_A'Q_B'X'+Q_AQ_BX$

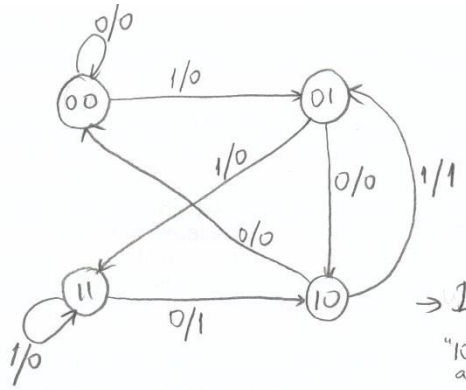


Q4. Design a Mealy type state machine with input X and output Y. Y should be 1 whenever the sequence **110 or 101** has been detected on X on the last 3 consecutive rising clock edges (or ticks). Otherwise, Y=0. *Use at most two D flip-flops*. An example input–output combination is given below:

X	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	1	0	0	1	0	1	1	0	0	1	1	0	0	1	1
Y	0	0	0	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0

You should show: a) State diagram. b) State table. c) Flip flop input equations and output equation.

a)



00 → No sequence
01 → 1 is found
10 → 10 is found
11 → 11 is found

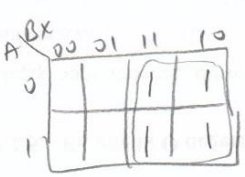
→ If "1" comes in state "10", output becomes one, and "1" sequence is found.

→ If "0" comes in state "11", output becomes one, and "10" sequence is found.

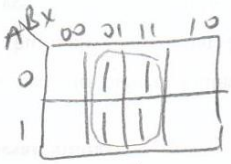
b)

A	B	X	A^*	B^*	y
0	0	0	0	0	0
0	0	1	0	1	0
0	1	0	1	0	0
0	1	1	1	1	0
1	0	0	0	0	0
1	0	1	0	1	1
1	1	0	1	0	1
1	1	1	1	1	0

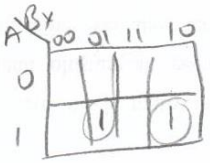
c)



$D_A = A^* = B$



$D_B = B^* = X$



$y = AB'X + ABX'$
$= A(B \oplus X)$

Q5. *A PN* flip-flop has four functions given below:

PN	**Functions**
00	Reset to 0
01	No change
10	Complement
11	Set to 1

a) Derive the characteristic equation for PN flip-flop. Show your work.

b) Draw the Mealy type state diagram of a sequence detector that detects the sequence 1101. You must have at most four states. When the sequence 1101 is detected, the output Z becomes 1.

c) Design the sequence detector usin two PN flip-flops. (Hint: You should determine the flip-flop input equations,P_A, N_A, P_B, N_B, and the output equation.)