Hacettepe University – Computer Engineering Dept.

BBM 231 Logic Design

2018-2019 Fall – FINAL EXAM

Date : January 30, 2019 Duration : 120 Minutes

Full Name :_____ Student ID : _____

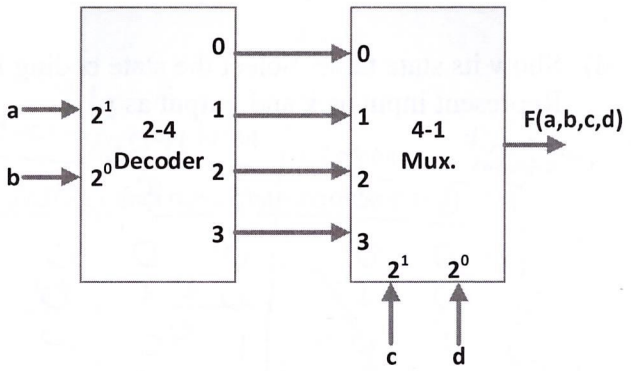
Ques.	1	2	3	4	Total
Points	25	25	25	25	100
Earned					

Question 1 (25 points):

The function F(a,b,c,d) is implemented by using a 2 to 4 decoder and 4 to 1 multiplexer as shown in the figure. (**a** is the most significant and **d** is the least significant bits.)

a) Find the Boolean function of F in its minimal form. (15)

b) Implement F using only <u>one 8 to 1 multliplexer and one inverter</u>. (10)



a	b	c	d	F
0	0	0	0	1
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

S_2 S_1 S_0

for 8x1 Mux

$F = d' = I_0$

$F = 0 = I_1$

$F = d = I_2$

$F = 0 = I_3$

$F = 0 = I_4$

$F = d' = I_5$

$F = 0 = I_6$

$F = d = I_7$

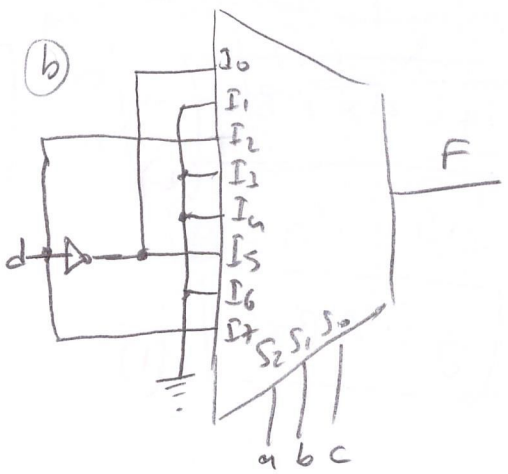
a)

ab \ cd	00	01	11	10
00	1			
01		1		
11			1	
10				1

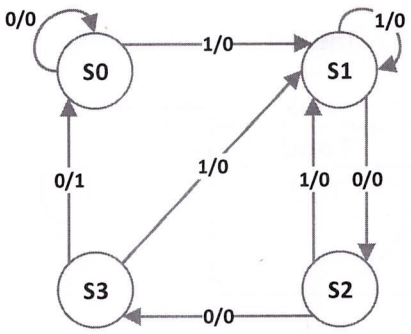
$F = a'b'c'd' + a'bc'd + ab'cd' + abcd$

$F = \Sigma(0, 5, 10, 15)$

b)



Question 2 (25 points): The state diagram given below represents a sequence detector. When the sequence is detected, the output becomes 1. S0 is the initial state. Answer the following questions based on this state diagram:



a) What is the difference between Mealy and Moore type state machines? Explain in one sentence. (3)

The output function depends only to state) in Moore machines while it depends on both input and state) in Mealy.

b) Is this a Mealy or Moore type state machine? (2) Mealy

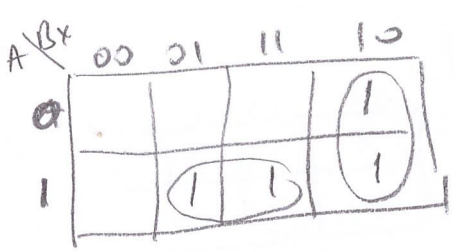
c) What is the sequence this machine detects? (5) 1 0 0 0

d) Show its state table. Select the state coding for S0, S1, S2, and S3 as 00, 01, 10, and 11, respectively. Represent input as **x** and output as **y**.

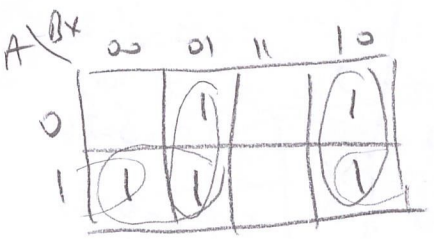
current state) A	B	input x	Next state A*	B*	output y	T_A	T_B
0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1
0	1	0	1	0	0	1	1
0	1	1	0	1	0	0	0
1	0	0	1	1	0	0	1
1	0	1	0	1	0	1	1
1	1	0	0	0	1	1	1
1	1	1	0	1	0	1	0

(5) (5)

e) Use T flip-flops and determine the flip flop input equations and output equation. Do not draw the circuit.



$T_A = Ax + Bx'$ (2)

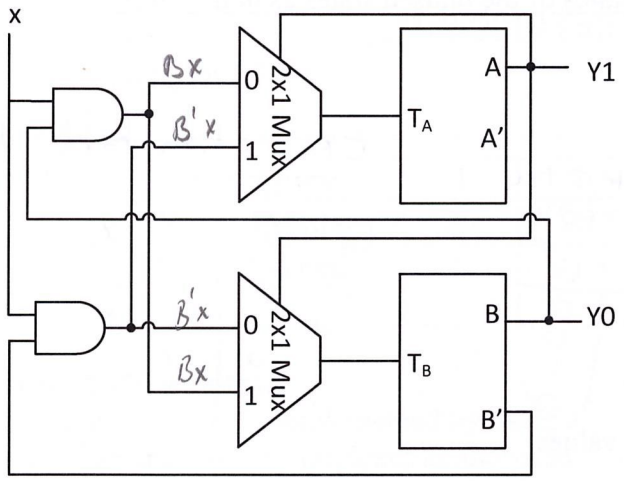


$T_B = B'x + Bx' + AB'$ or

$T_B = B'x + Bx' + Ax'$ (2)

$y = ABx'$ (1)

Question 3 (25 points): You are given a sequential circuit with one input (x) and two outputs (Y1 and Y0). The circuit is a counter implemented with two T flip flops.



$T_A = A'(Bx) + A(B'x)$

$T_B = A'(B'x) + A(Bx)$

(5) Flip-flop input equations

$Y1 = A$

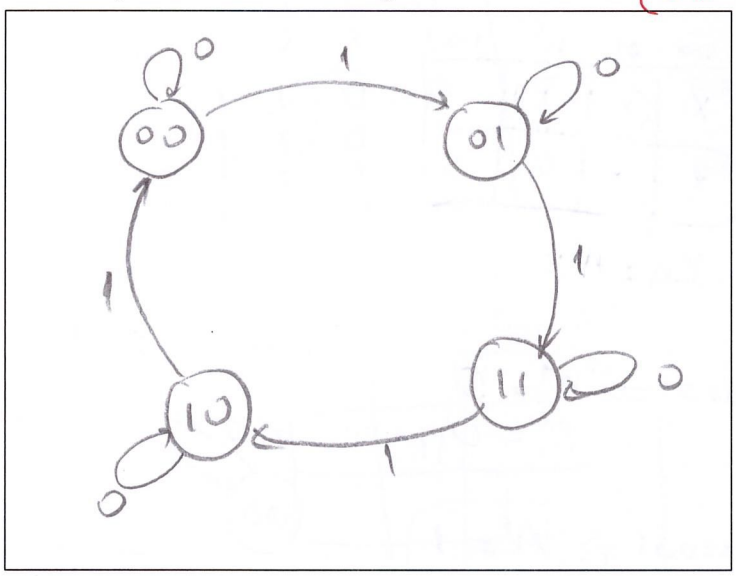
$Y0 = B$

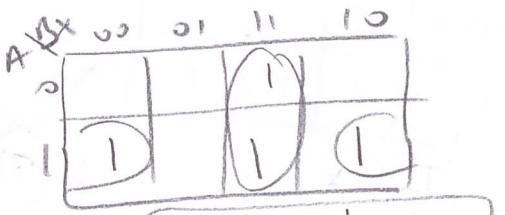
a) Show the state table, flip flop input equations (T_A and T_B) and next state equations.

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

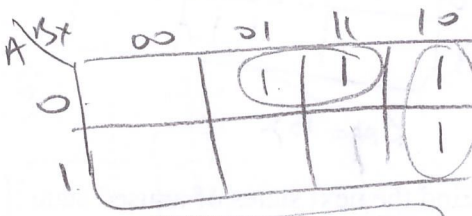
(5)

b) Draw the state diagram of the circuit. (5)





$A^* = Ax' + Bx$



$B^* = A'x + Bx'$

(5)

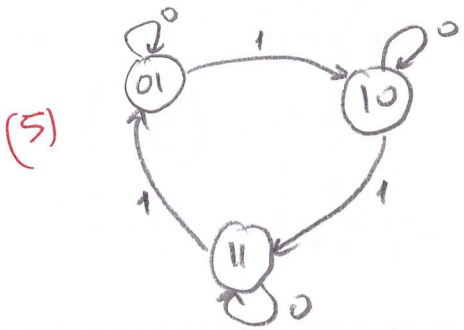
Next state equations

c) What is the counting sequence of this circuit? (5)

0, 1, 3, 2, 0, ...

Question 4 (25 points): Design a counter that counts with the repeated sequence 1,2,3,1,2,3,1… when the input x is 1. If the input is zero, the counter remains at the same state. Design this counter by using J-K flip flops and additional gates if necessary. Treat the next states of the unused states as don't cares.

a) Draw the state diagram.



(5)

Characteristic table of JK

J	K	Q^*
0	0	Q
0	1	0
1	0	1
1	1	Q'

Excitation table of JK

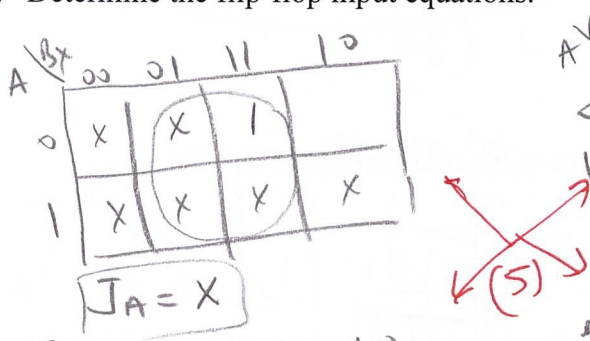
Q	Q^*	J	K
0	0	0	x
0	1	1	x
1	0	x	1
1	1	x	0

b) Fill the state table along with JK flip flop input values.

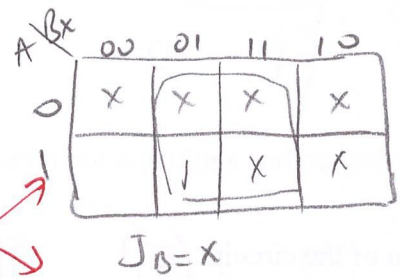
A	B	x	A^*	B^*	J_A	K_A	J_B	K_B
0	0	0	x	x	x	x	x	x
0	0	1	x	x	x	x	x	x
0	1	0	0	1	0	x	x	0
0	1	1	1	0	1	x	x	1
1	0	0	1	0	x	0	0	x
1	0	1	1	1	x	0	1	x
1	1	0	1	1	x	0	x	0
1	1	1	0	1	x	1	x	0

(5) (5)

c) Determine the flip-flop input equations.

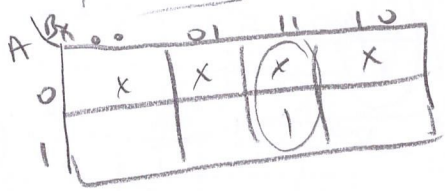


$J_A = X$

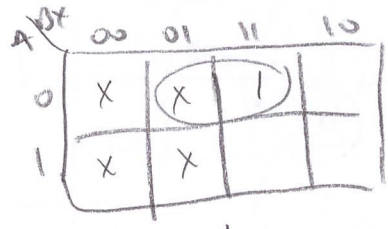


$J_B = X$

(5)



$K_A = Bx$



$K_B = A'x$

d) Find the next states of unused state. (5)

State equations.

$A^* = J_A A' + K_A' A$

$A^* = xA' + ABx$

$B^* = J_B B' + K_B' B$

$B^* = xB' + A'Bx$

when: ABx = 000 ⇒ $A^* = 0$, $B^* = 0$

when: ABx = 001 ⇒ $A^* = 1$, $B^* = 1$

Unused state.