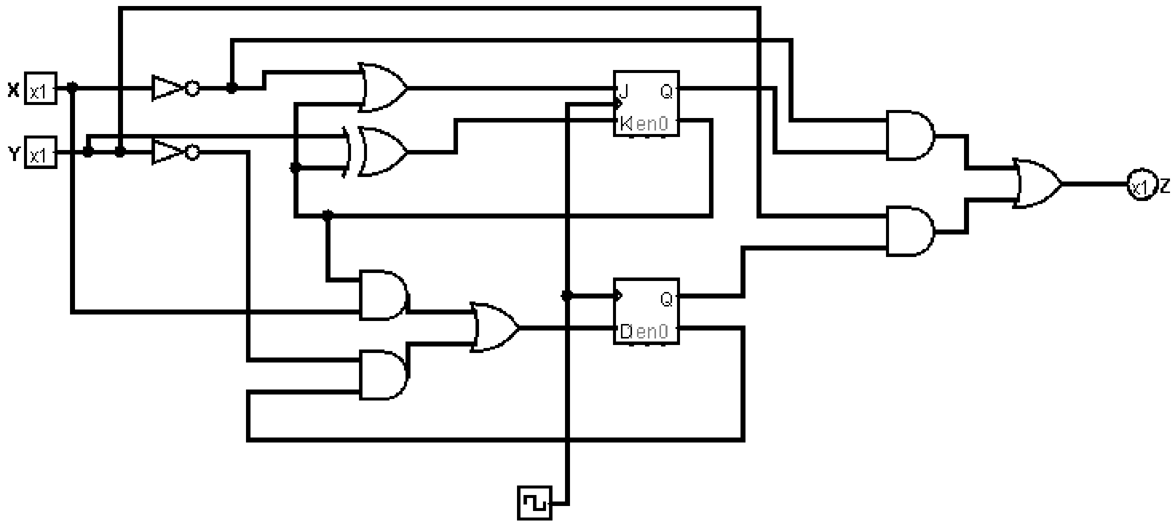
BLG 231E - Digital Circuits

Assignment 5

Name Surname: Seyfülmülük Kutluk
Student ID: 150180073
CRN: 11623

1) Analyze the synchronous sequential circuit given in the figure below by answering following questions:



a) Determine which model (Mealy or Moore) the circuit uses. Explain. (3 points)

Answer a)

In this circuit, the output is controlled by both of the current input values and current state. The Mealy model is used since in Mealy model the output is controlled by both of the current input and current state.

The Mealy Model is used.

b) Determine the expressions for the input functions that drive the J0, K0 , and D1 inputs of the flipflops. (12 points)

Answer b)

J0 = X’ + Q0’   Because the X and Q0 are connected to the inputs of OR gate. And the output of OR gate is connected to the JO

KO = Y ⊕ Q0’   Because the Y and Q0 are connected to the inputs of XOR gate. And the output of Xor gate is connected to the KO

D1= X.Q0 + Y’.Q1’   Because the X and Q0 are connected to inputs of the AND gate. The Y and Q1 are also connected to another AND gate. The Outputs of both AND gates are connected to the OR gate. And lastly the output of the OR gate is connected to the D1.

J0 = X’ + Q0’
KO = Y ⊕ Q0’
D1= X.Q0’ + Y’.Q1’

c) Determine the expressions for the next states Q0 + and Q1 + (use Q0 for the J-K flip-flop, and Q1 for the D flip-flop) and the expression for the output Z. (25 points)

Answer c)
1) The next state for J-K Flip-Flop is $Q0^{+}$ = J0. Q0’ + K0’. Q0
We know the J0 and K0 from the question “b”
J0 = X + Q0
KO = Y ⊕ Q0
We will Find $\overline{KO}$
$\overline{K0}$ =(Y ⊕ Q0’)’   since Y ⊕ Q0’ = Y’.Q0’ + Y.Q0
= (Y’.Q0’ + Y.Q0)’   De Morgan’s Theorem
= (Y’.Q0’)’ . (Y.Q0)’   De Morgan’s Theorem
= (Y + Q0) . (Y.Q0)’   De Morgan’s Theorem
= (Y + Q0) . (Y’ + Q0’)   Distrubutive
= Y.Y’ + Y.Q0’ + Q0. Y’ + Q0.Q0’   Inverse
=0 +Y.Q0’ + Q0. Y + 0   Identity
= Y.Q0’ + Q0. Y
$\overline{K0}$ = Y.Q0’ + Q0. Y’

$Q0^{+}$ = J0. Q0 + K0. Q0
$Q0^{+}$ = (X’ + Q0’). Q0’ + (Y.Q0’ + Q0. Y’). Q0   Distrubutive
=X’.Q0’+ Q0’ . Q0’ + Y.Q0 .Q0’ + Q0. Y’.Q0   Idempotency
=X’.Q0’+ Q0’ + Y.Q0 .Q0’ + Q0. Y’.Q0   Idempotency
=X’.Q0’+ Q0’ + Y.Q0 .Q0’ + Q0. Y’   Inverse
=X’.Q0’+ Q0’ + Y.0 + Q0. Y’   Dominance
=X’.Q0’+ Q0’ + Q0. Y’   Absorption
= Q0’ + Q0. Y’   Absorption
= Q0 + Y
$Q0^{+}$= Q0 + Y

2) The next state for D Flip-Flop is $Q1^{+}$=(D1)’

We know the D1 from example “b”

(D1)’= (X.Q0’ + Y’.Q1’)’

$Q1^+$= (X.Q0’ + Y’.Q1’)’

3) Z= Q0.X’ + Y.Q1

Because the X and Q0 are connected to inputs of the AND gate. The Y and Q1 are also connected to another AND gate. The Outputs of both AND gates are connected to the OR gate. And lastly the output of the OR gate is connected to the Z.

Results for 1.c)
$Q0^+$= Q0 + Y
$Q1^+$= (X.Q0’ + Y’.Q1’)’
Z= Q0.X’ + Y.Q1

d) Construct the state/output table. (35 points)

Answer d)

Truth Table For $Q1^+$

Q1	Q0	x	y	$Q1^+$
0	0	0	0	**0**
0	0	0	1	**1**
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	**1**
1	0	0	0	**1**
1	0	0	1	**1**
1	0	1	0	**0**
1	0	1	1	**0**
1	1	0	0	**1**
1	1	0	1	**1**
1	1	1	0	**1**
1	1	1	1	**1**

Truth Table For $Q0^+$

Q0	y	$Q0^+$
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

Truth Table For Z

Q1	Q0	x	y	Z
0	0	0	0	**0**
0	0	0	1	**0**
0	0	1	0	**0**
0	0	1	1	**0**
0	1	0	0	**1**
0	1	0	1	**1**
0	1	1	0	**0**
0	1	1	1	**0**
1	0	0	0	**0**
1	0	0	1	**1**
1	0	1	0	**0**
1	0	1	1	**1**
1	1	0	0	**1**
1	1	0	1	**1**
1	1	1	0	**0**
1	1	1	1	**1**

State/ Output Table: We draw the table using truth table value of the Q1, Q0, $Q1^{+}$, $Q0^{+}$ and Z

$Q1^{+}$ $Q0^{+}$,Z	XY				
Q1 Q0		00	01	10	11
	00	00,0	11,0	00,0	01,0
	01	01,1	11,1	01,0	11,0
	10	10,0	11,1	00,0	01,1
	11	11,1	11,1	11,0	11,1

A=00 , B=01, C=10 , D=11

S^{+},Z	XY				
S^{+}		00	01	10	11
	A	A,0	D,0	A,0	B,0
	B	B,1	D,1	B,0	D,0
	C	C,0	D,1	A,0	B,1
	D	D,1	D,1	D,0	D,1

e) Draw the state transition diagram. (25 points)

Answer e)

A= 00 , B=01, C=10 , D=11