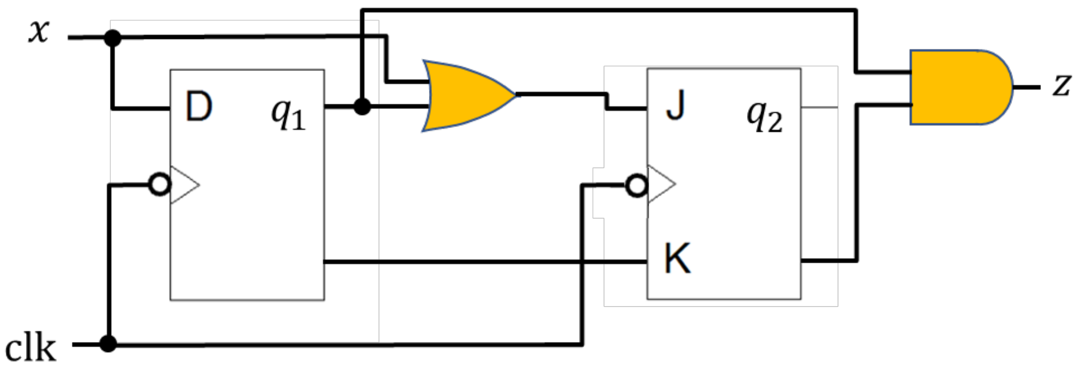
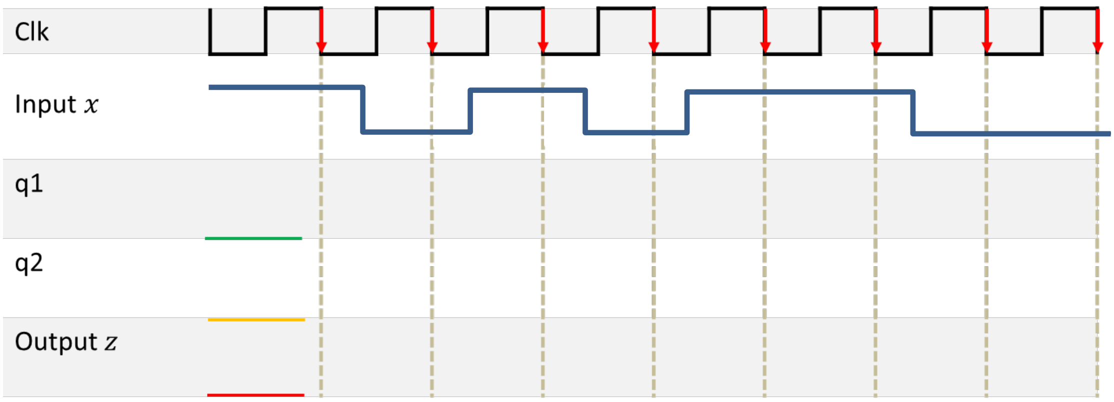
EE 2000 Logic Circuit Design
Semester A 2024/25

Tutorial 9

1. For the following circuits, (a) determine the state table and state diagram (calling the states 00, 01, 10, 11), (b) complete the timing diagram as shown.





$D = x$ $J = q_1 + x$ $K = q_1'$ $z = q_1 q_2'$

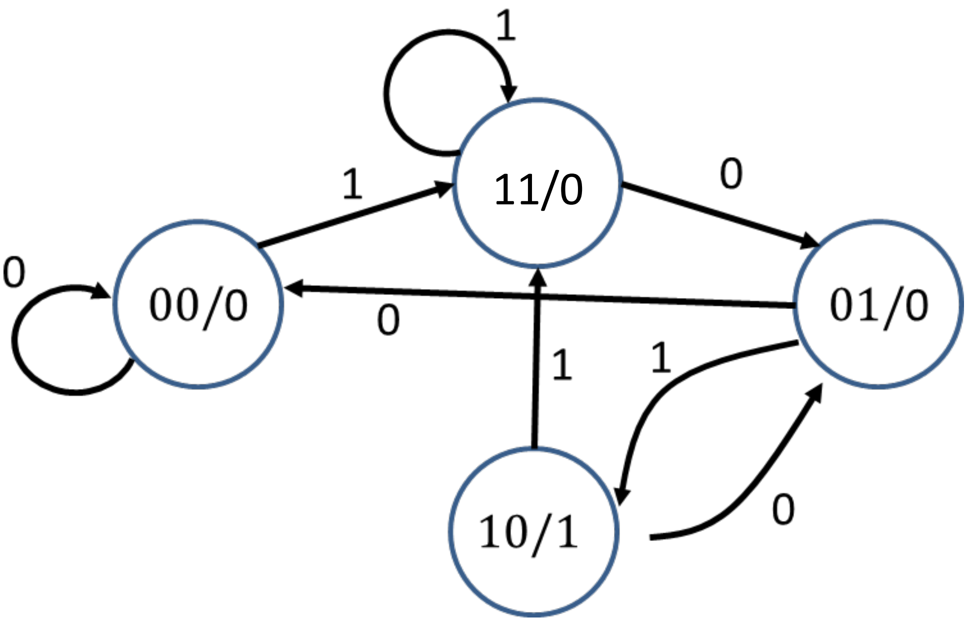
Analysis Table

Present State (PS) q_1q_2	Input x	Present Output z	Flip-Flops' Excitations D	J	K	Next State (NS) $q_1^*q_2^*$
(0 0)	0	0	0	0	1	(0 0)
	1	0	1	1	1	(1 1)
(0 1)	0	0	0	0	1	(0 0)
	1	0	1	1	1	(1 0)
(1 0)	0	1	0	1	0	(0 1)
	1	1	1	1	0	(1 1)
(1 1)	0	0	0	1	0	(0 1)
	1	0	1	1	0	(1 1)

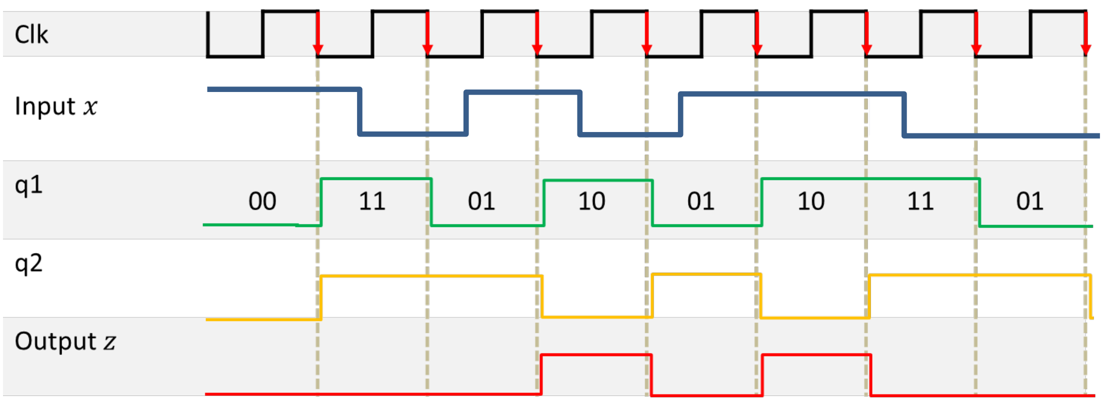
State Table

Present State	Input X		Present Output Z
	0	**1**	
00	00	11	0
01	00	10	0
10	01	11	1
11	01	11	0

State Diagram



Timing Diagram



2. Design a Mealy system using D-FFs with one input x and one output z such that z = 1 if x has been 1 for exactly two consecutive clock-times. A sample input/output trace for such a system is shown below.

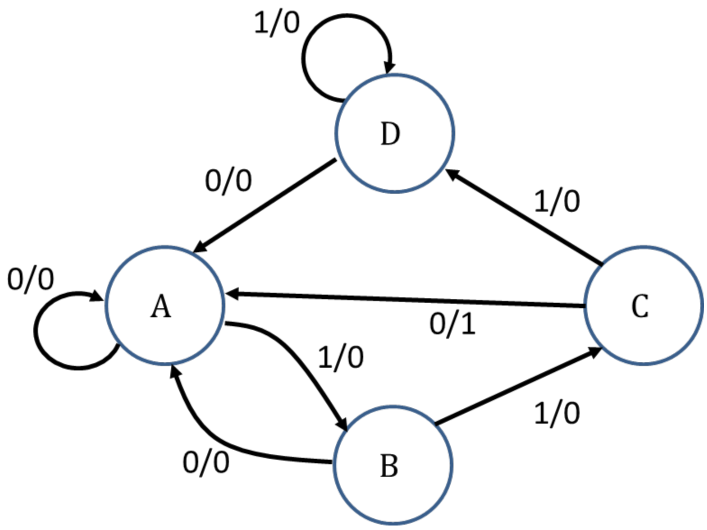
x	0	1	1	1	1	0	1	1	0	0	1	0
z	0	0	0	0	0	0	0	0	1	0	0	0

A: Input is '0'

B: one '1' is detected

C: two '1's are detected

D: more than two '1's are detected



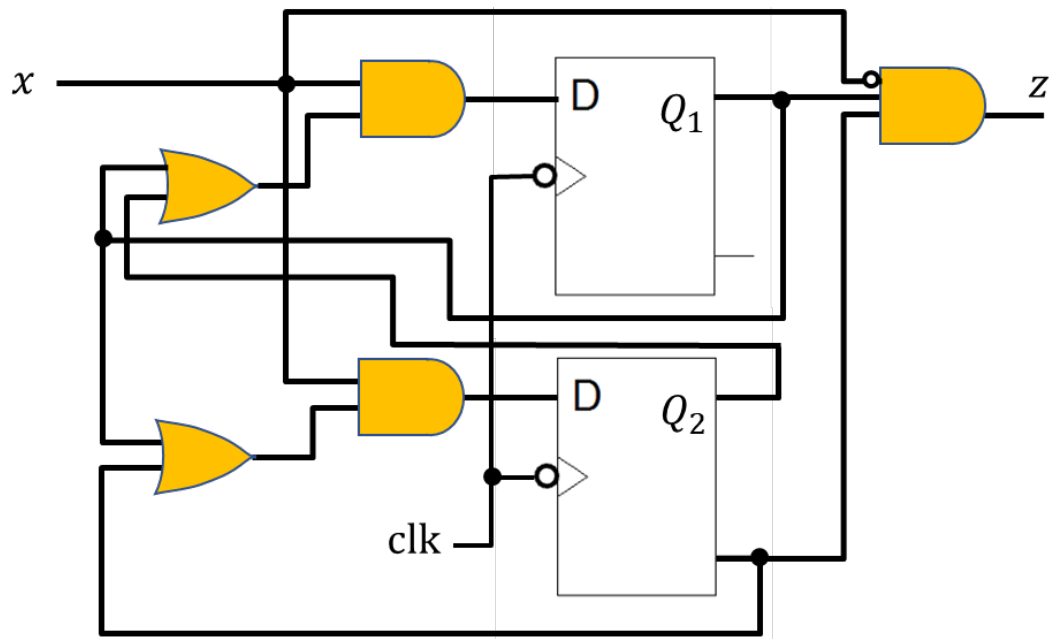
Present State	**Input X**	
	0	**1**
A	A/0	B/0
B	A/0	C/0
C	A/1	D/0
D	A/0	D/0

Present State (Q_1Q_2)	**Input X**	**Next stage**		**Output Z**
		Q_1^*	Q_2^*	
A (0 0)	0	0	0	0
A (0 0)	1	0	1	0
B (0 1)	0	0	0	0
B (0 1)	1	1	0	0
C (1 0)	0	0	0	1
C (1 0)	1	1	1	0
D (1 1)	0	0	0	0
D (1 1)	1	1	1	0

$$Q_1^* = D_1 = x(Q_1 + Q_2)$$

$$Q_2^* = D_2 = x(Q_1 + Q_2')$$

$$z = x'Q_1Q_2'$$



x
D
Q_1
D
Q_2
clk
z

3. Design a Moore system with one input x and one output z such that z = 1 if a sequence of "101" has been detected (overlapping is allowed). A sample input/output trace for such a system is shown below.

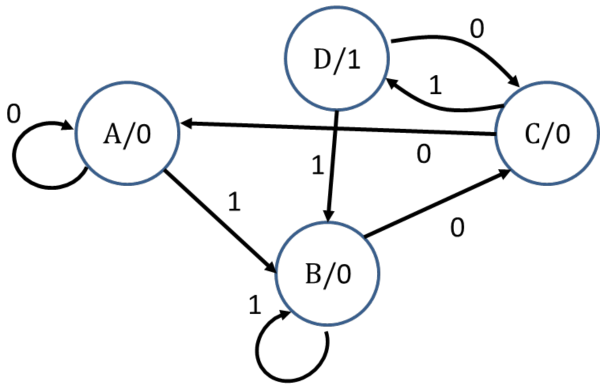
x	0	1	0	1	1	0	1	0	1	0	0	0
z	0	0	0	0	1	0	0	1	0	1	0	0

A: Input is '0'

B: one '1' is detected

C: Sequence "10" is detected

D: Sequence "101" are detected and output 1



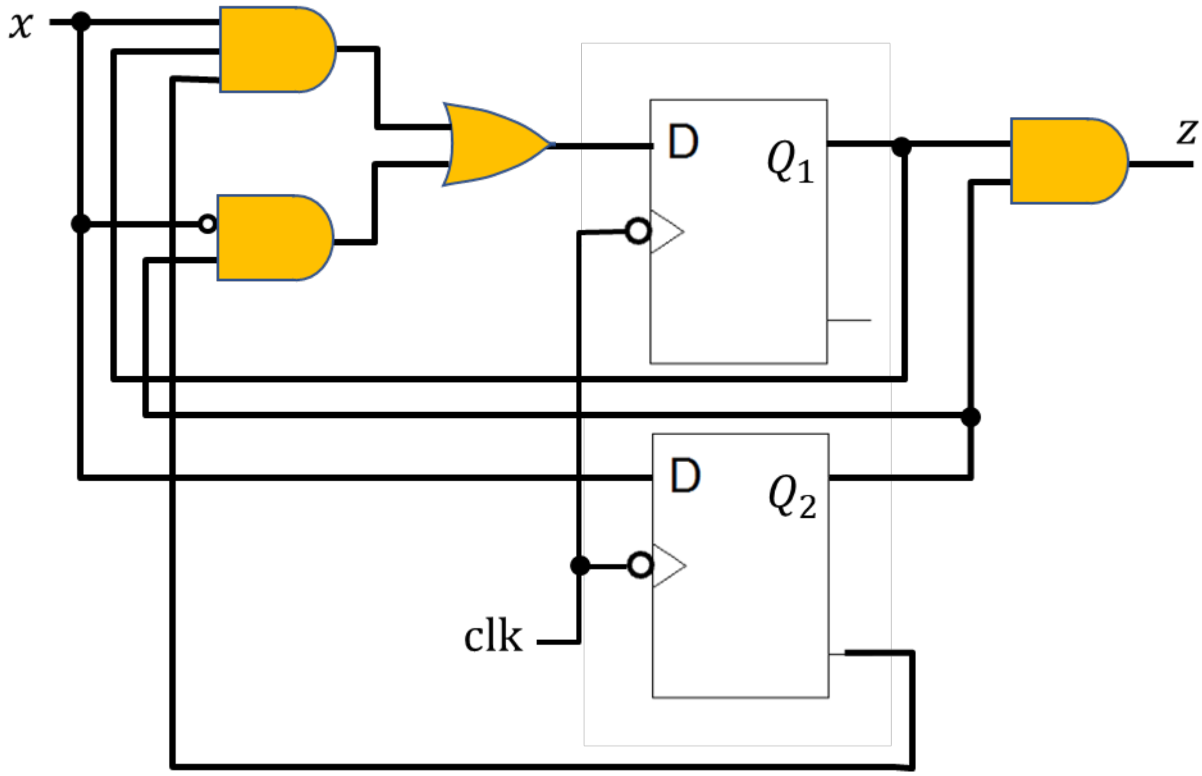
Present State	Input X: 0	Input X: 1	Present Output Z
A	A	B	0
B	C	B	0
C	A	D	0
D	C	B	1

Present State (Q_1Q_2)	Input X	Next stage Q_1^*	Next stage Q_2^*	Output Z
A (0 0)	0	0	0	0
A (0 0)	1	0	1	0
B (0 1)	0	1	0	0
B (0 1)	1	0	1	0
C (1 0)	0	0	0	0
C (1 0)	1	1	1	0
D (1 1)	0	1	0	1
D (1 1)	1	0	1	1

$$Q_1^* = D_1 = xQ_1Q_2' + x'Q_2$$

$$Q_2^* = D_2 = x$$

$$z = Q_1Q_2$$



x
z
D
Q_1
D
Q_2
clk

4. Use both the partitioning method to minimize the number of states in the state table shown.

	Next state		Output	
Present state	$x=0$	$x=1$	$x=0$	$x=1$
A	F	B	0	0
B	D	C	0	0
C	F	E	0	0
D	G	A	1	0
E	D	C	0	0
F	F	B	1	1
G	G	H	0	1
H	G	A	1	0

	0	1
A	F/0	B/0
B	D/0	C/0
C	F/0	E/0
D	G/1	A/0
E	D/0	C/0
F	F/1	B/1
G	G/0	H/1
H	G/1	A/0

P		0	1
1	A	F/0	B/0
	B	D/0	C/0
	C	F/0	E/0
	E	D/0	C/0
2	G	G/0	H/1
3	D	G/1	A/0
	H	G/1	A/0
4	F	F/1	B/1

P		0	1
1	A	F/0	B/0
	C	F/0	E/0
2	B	D/0	C/0
	E	D/0	C/0
3	G	G/0	H/1
4	D	G/1	A/0
	H	G/1	A/0
5	F	F/1	B/1

	I	J
A=C	F/0	B/0
B=E	D/0	C/0
G	G/0	D/1
D=H	G/1	A/0
F	F/1	B/1