CE232 DIGITAL SYSTEM

Topic 10. Simplification of Sequential Circuit

Prepared by Nabila Husna Shabrina

Contact : nabila.husna@umn.ac.id

Subtopic

10.2 Moore and Mealy State Diagram

10.2 State Diagram Simplification

10.1 Moore and Mealy State Diagram

10.1 Moore and Mealy State Diagram

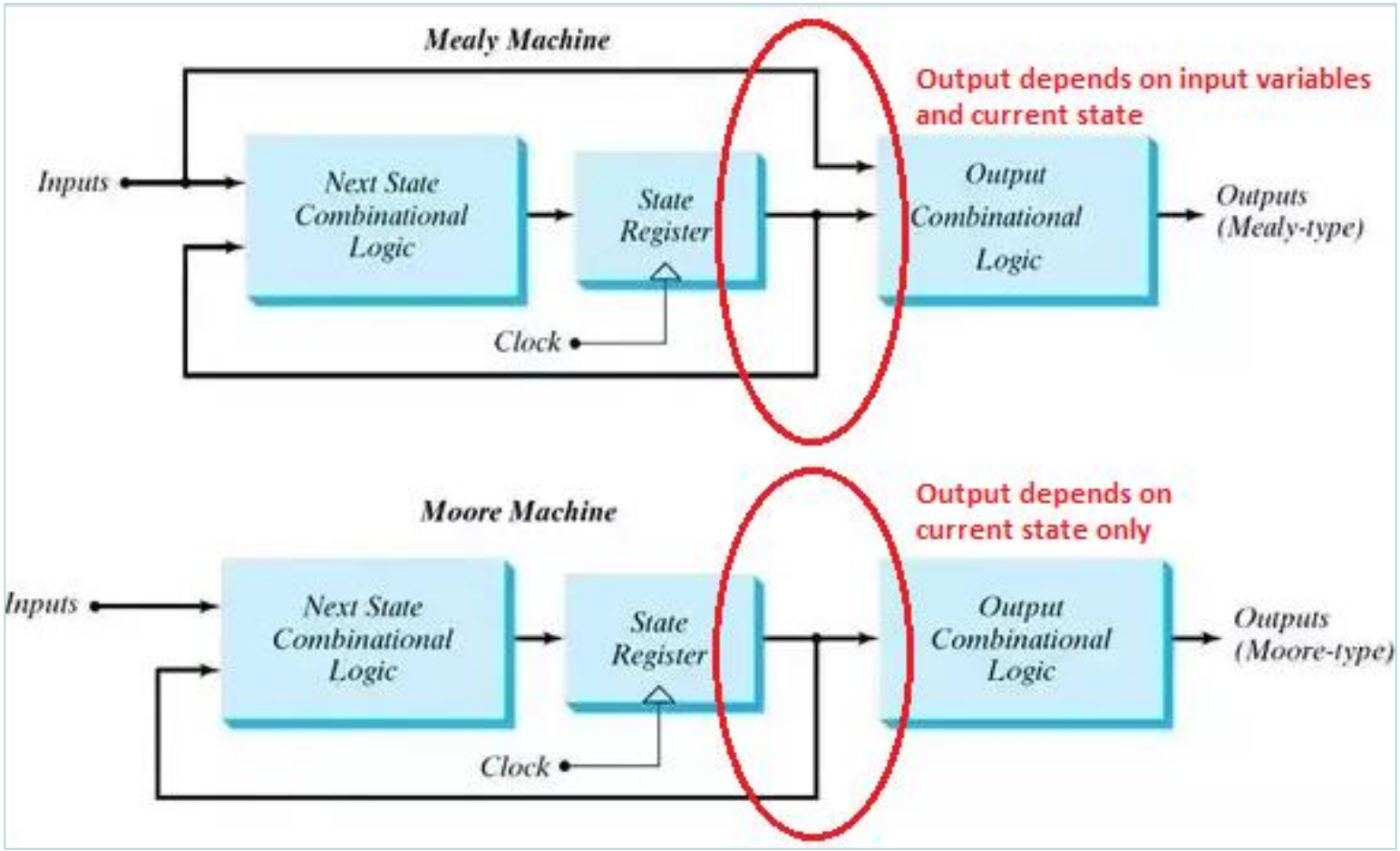
There are two models developed to representing sequential circuit

- Moore circuit/ Moore state machine : the output is the function of present state
- Mealy circuit/Mealy state machine : the output is the function of present state as well as input

→ The difference Is only in the way the output is generated

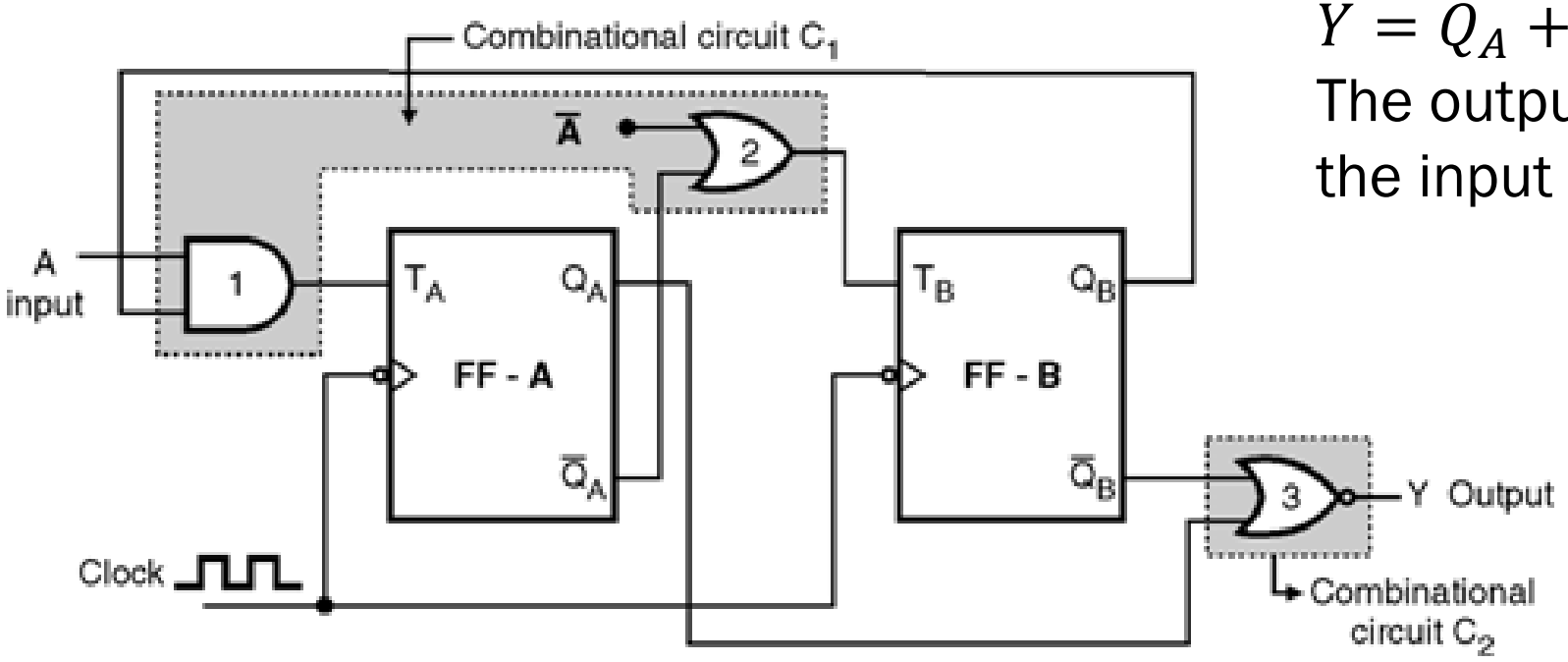
10.1 Moore and Mealy State Diagram

Moore vs Mealy



10.1 Moore and Mealy State Diagram

Example of Moore circuit



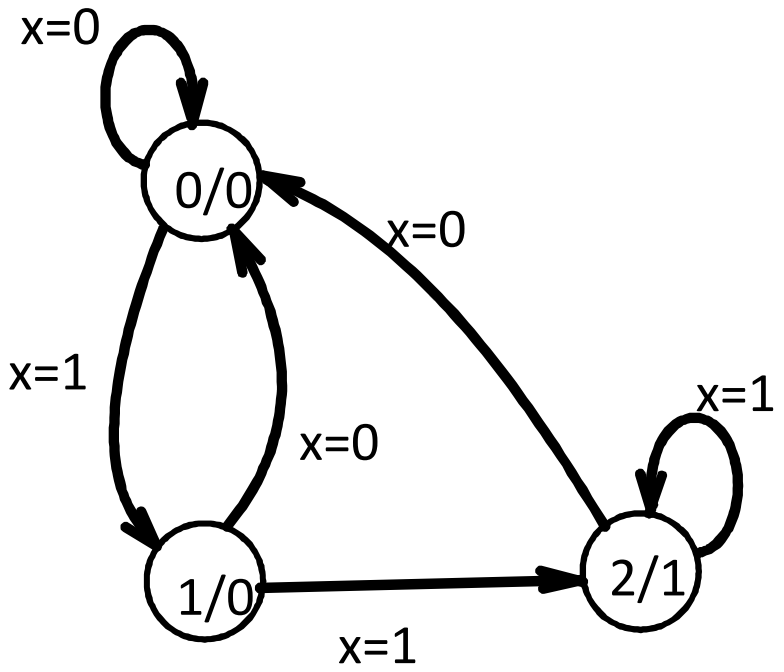
$$Y = Q_A + \overline{Q_B}$$

The output independent of the input A

10.1 Moore and Mealy State Diagram

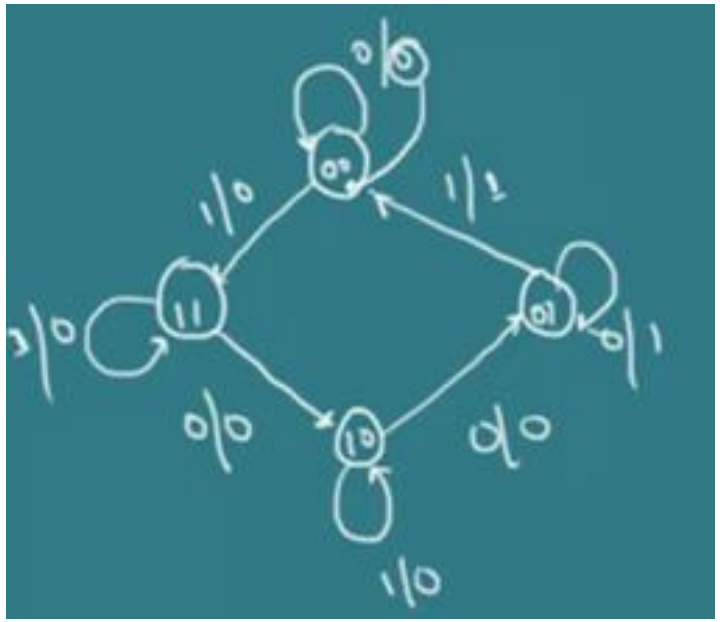
Example of Moore state diagram

Present State	Next State x=0	Next State x=1	Output
0	0	1	0
1	0	2	0
2	0	2	1



10.1 Moore and Mealy State Diagram

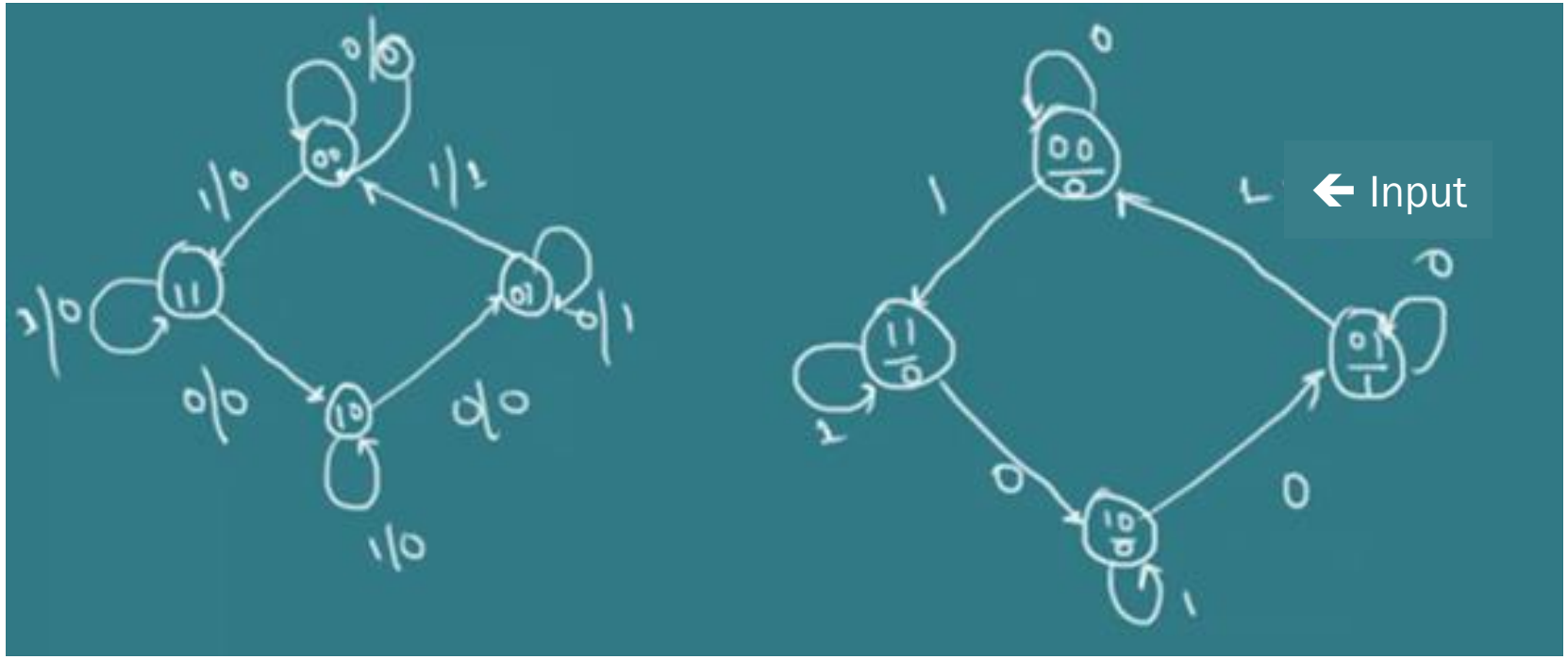
Example of Moore state diagram



PS	NS		OUTPUT	
	X=0	X=1	X=0	X=1
00	00	11	0	0
01	01	00	1	1
10	01	10	0	0
11	10	11	0	0

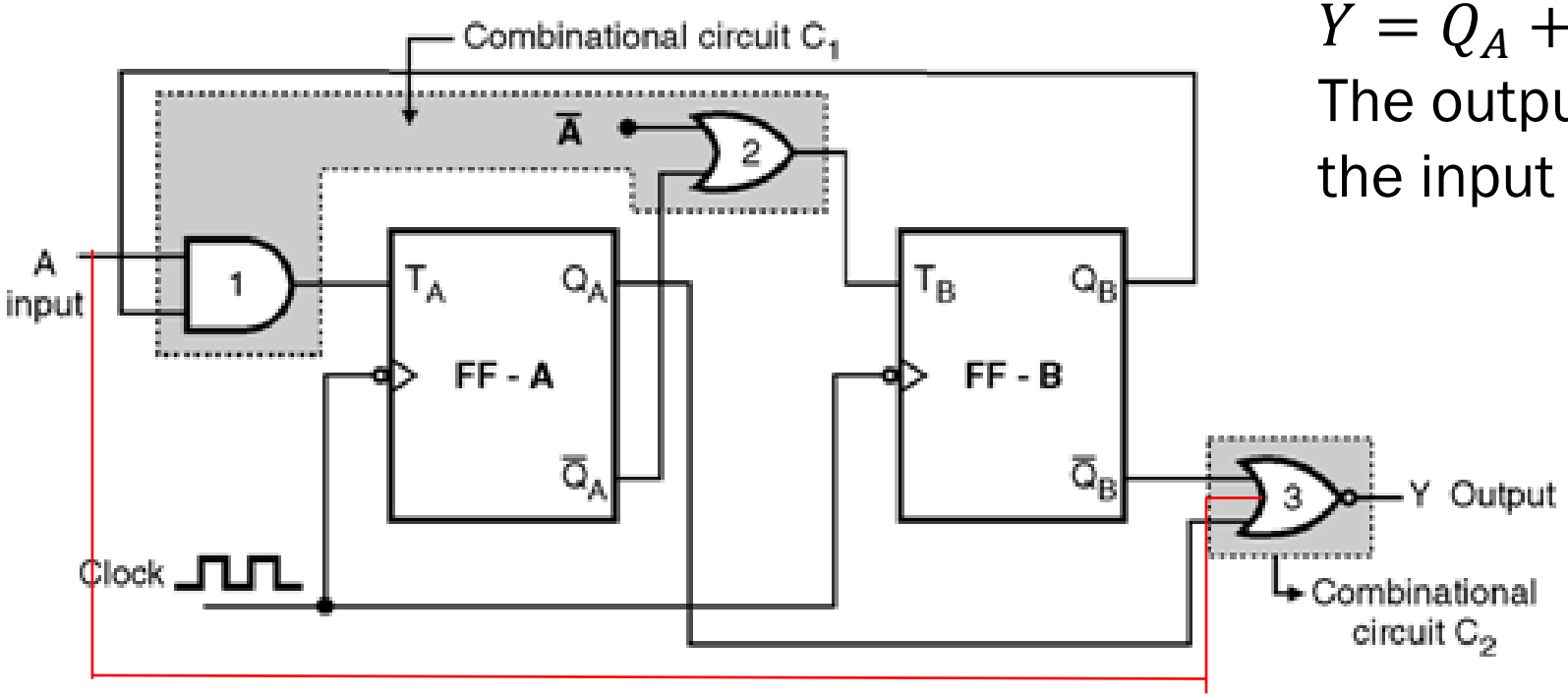
10.1 Moore and Mealy State Diagram

Example of Moore state diagram



10.1 Moore and Mealy State Diagram

Example of Mealy circuit



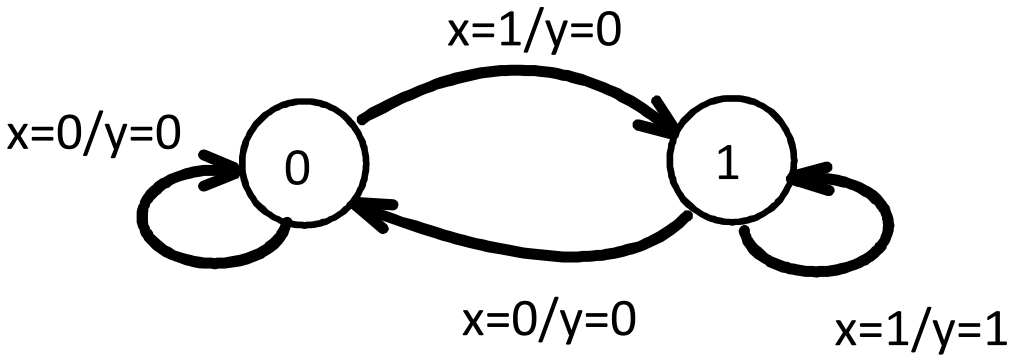
$$Y = Q_A + \overline{Q_B} + A$$

The output also depend on the input A

10.1 Moore and Mealy State Diagram

Example of Mealy state diagram

Present State	Next State x=0	Next State x=1	Output x=0	Output x=1
0	0	1	0	0
1	0	1	0	1



10.2 State Diagram Simplification

10.2 State Diagram Simplification

Equivalent state

- Two states are equivalent if their **response for each possible input** sequence is an **identical output** sequence.
- Alternatively, two states are equivalent if **their outputs** produced for each input symbol is **identical** and **their next states** for each input symbol are the **same or equivalent.**

10.2 State Diagram Simplification

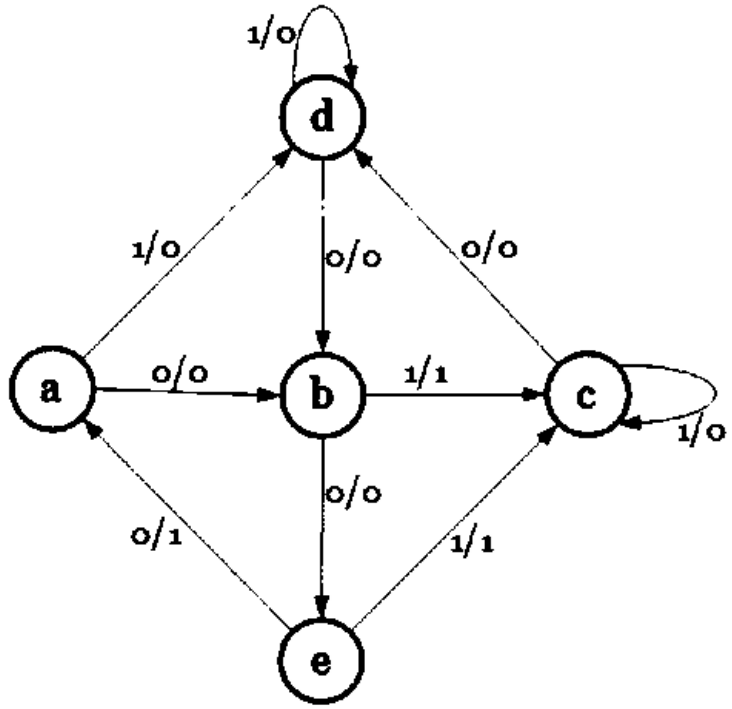
Step

1. Make state diagram
2. Find the equivalent states, remove the redundant state
3. Make a reduce state table
4. Construct the simplified state diagram

10.2 State Diagram Simplification

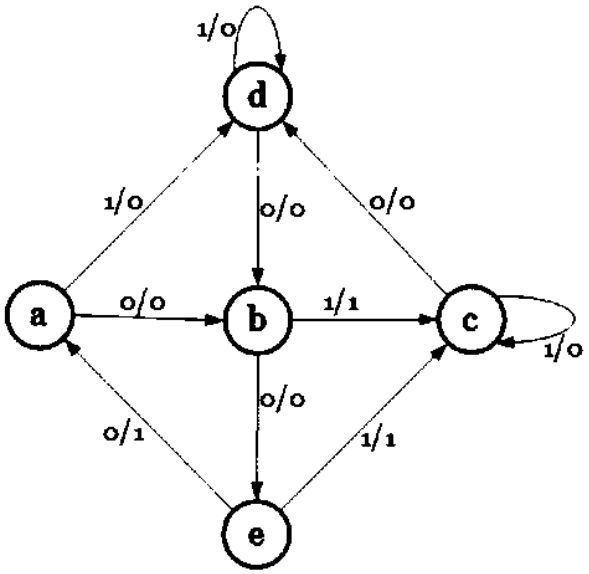
Example.

Simplified the given state diagram



10.2 State Diagram Simplification

Step 1. Make state diagram



Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	d	0	0
b	e	c	0	1
c	d	c	0	0
d	b	d	0	0
e	a	c	1	1

10.2 State Diagram Simplification

Step 2. Find the equivalent states, remove the redundant state

Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	d	0	0
b	e	c	0	1
c	d	c	0	0
d	b	d	0	0
e	a	c	1	1

Equivalent states

A and **D** are found as equivalent states. So, **replace D by A and remove D**

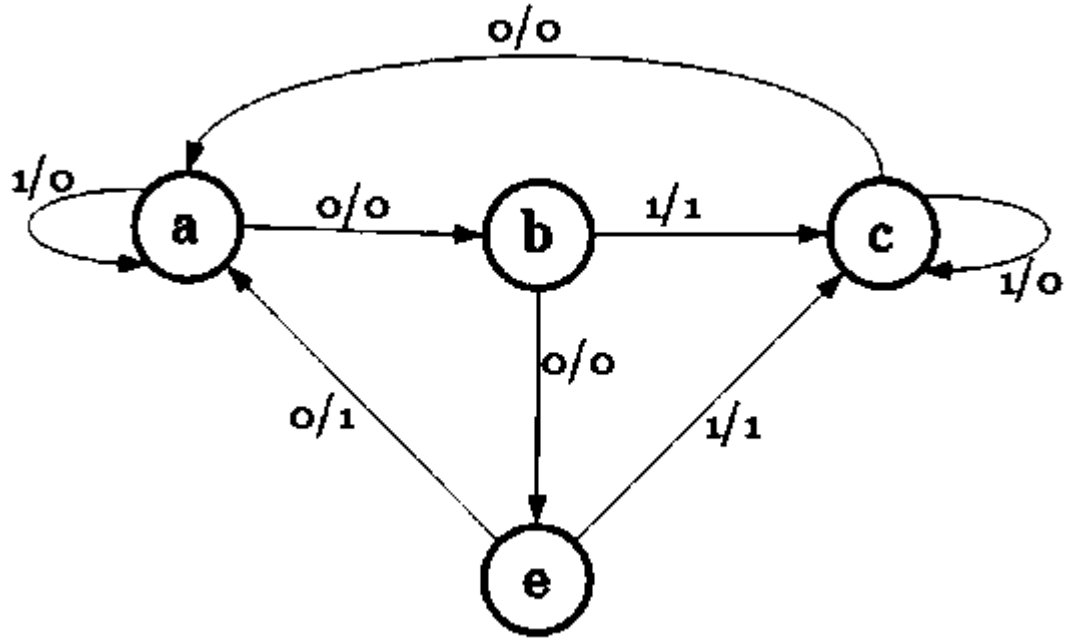
10.2 State Diagram Simplification

Step 3. Make a reduce state table

Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	a	0	0
b	e	c	0	1
c	a	c	0	0
e	a	c	1	1

10.2 State Diagram Simplification

Step 4. Construct the simplified state diagram



10.2 State Diagram Simplification

Example.

Construct a simplified state diagram from the following state table.

Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	c	0	0
b	b	d	0	0
c	b	a	0	0
d	e	c	1	0
e	b	d	0	0

10.2 State Diagram Simplification

Answer :

Find the equivalent states, remove the redundant state

Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	c	0	0
b	b	d	0	0
c	b	a	0	0
d	e	c	1	0
e	b	d	0	0

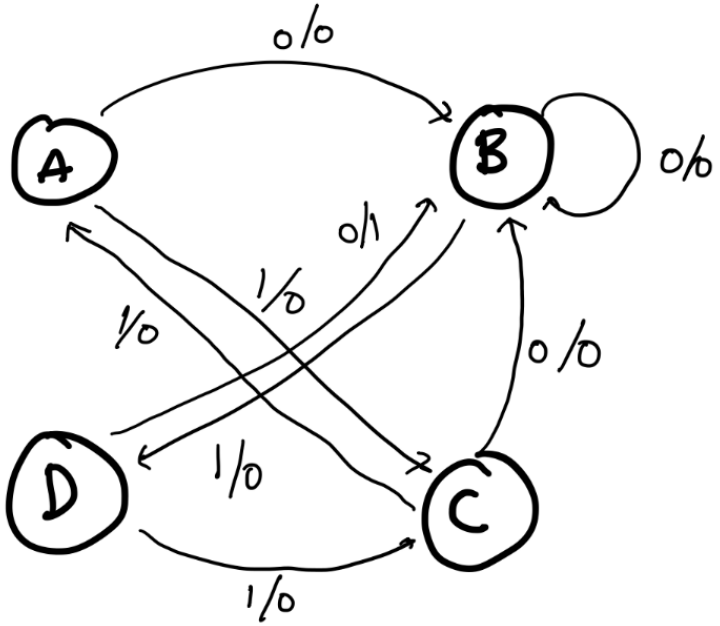
Equivalent states

D and **E** are found as equivalent states. So, **replace E by B and remove E**

10.2 State Diagram Simplification

Make the simplified state table and state diagram

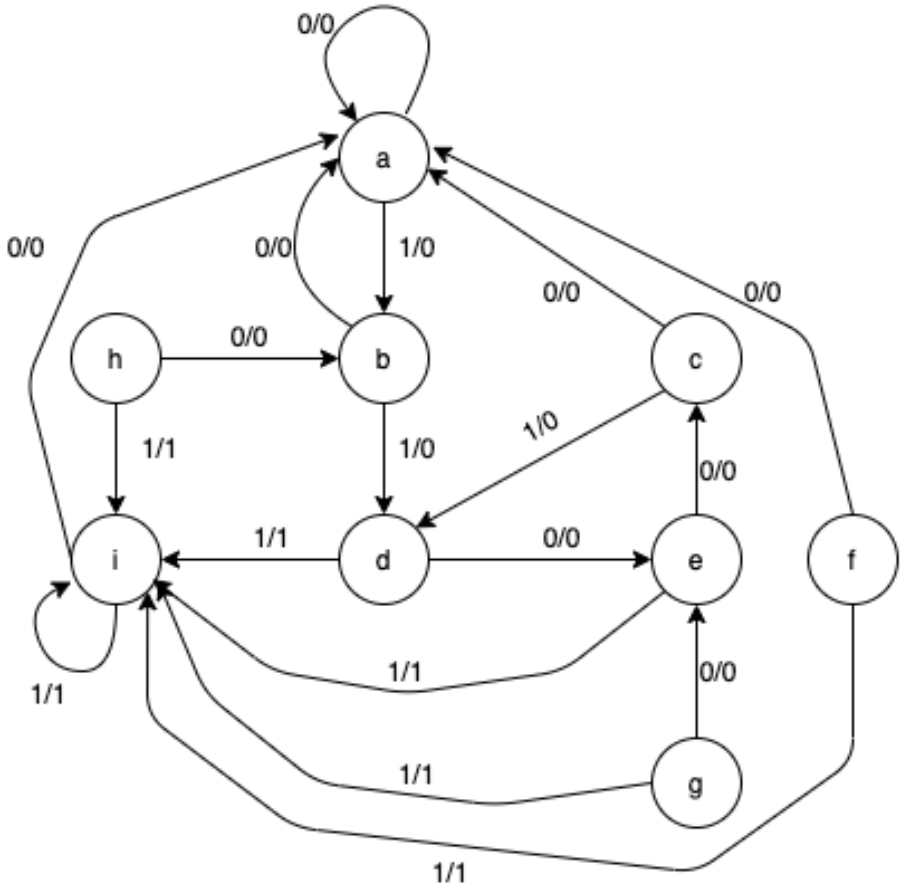
Present state	Next state		Output	
	X = 0	X = 1	X = 0	X = 1
a	b	c	0	0
b	b	d	0	0
c	b	a	0	0
d	b	c	1	0



10.2 State Diagram Simplification

Assignment.

Simplified the given state diagram



References

M. Morris Mano, Digital Design, 5th ed, Prentice Hall, 2012, **Chapter 5**

Next Topic : Design of Sequential Circuit