Sairam INSTITUTIONS

Sri SAI RAM ENGINEERING COLLEGE
INSTITUTE OF TECHNOLOGY
West Tambaram, Chennai - 44

YEAR	SEM
II	III

CS 8351

DIGITAL PRINCIPLES AND SYSTEM DESIGN
(Common to CSE & IT)

UNIT NO. 3

3.4STATE REDUCTION AND STATE ASSIGNMENT

Version: 1.0

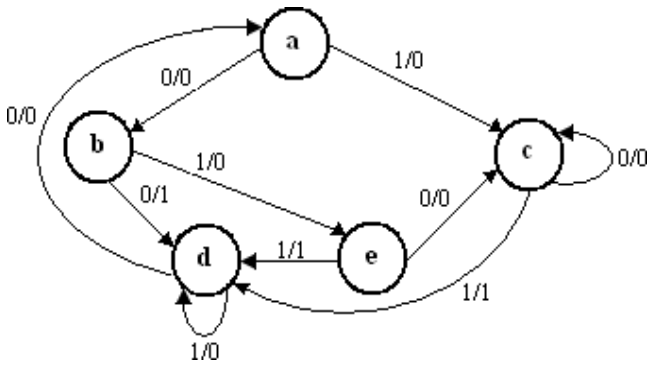
4 QUALITY EDUCATION

NBA NATIONAL BOARD OF ACCREDITATION | NAAC NATIONAL ASSESSMENT AND ACCREDITATION COUNCIL A+ | nirf NATIONAL INSTITUTIONAL RANKING FRAMEWORK | ISO 9001 : 2015 BUREAU VERITAS Certification

STATE REDUCTION/ MINIMIZATION

- The state reduction is used to avoid the redundant states in the sequential circuits.
- The reduction in redundant states reduces the number of required Flip-Flops and logic gates, reducing the cost of the final circuit.
- The two states are said to be redundant or equivalent, if every possible set of inputs generate exactly same output and same next state.
- When two states are equivalent, one of them can be removed without altering the input-output relationship.
- Since 'n' Flip-Flops produced 2n state, a reduction in the number of states may result in a reduction in the number of Flip-Flops.
- The need for state reduction or state minimization is explained with one example.

1.Reduce the following state diagram



State diagram

Step 1: Determine the state table for given state diagram

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

State table

Step 2: Find equivalent states

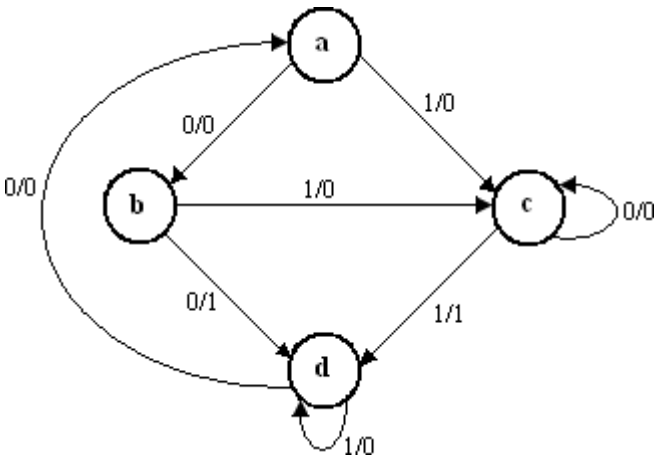
- From the above state table **c** and **e** generate exactly same next state and same output for every possible set of inputs.
- The state **c** and **e** go to next states **c** and **d** and have outputs 0 and 1 for x=0 and x=1 respectively.
- Therefore state **e** can be removed and replaced by **c**. The final reduced state table is shown below.

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

Reduced state table

Step 3: Reduced State Diagram:

The state diagram for the reduced table consists of only four states and is shown below.



2.Reduce the number of states in the following state table and tabulate the reduced state table.

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

Soln:

- From the above state table **e** and **g** generate exactly same next state and same output for every possible set of inputs.
- The state **e** and **g** go to next states **a** and **f** and have outputs 0 and 1 for x=0 and x=1 respectively.
- Therefore state **g** can be removed and replaced by **e**.

Step1:Reduced state table-1

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

- Reduced state table-1

- Now states d and f are equivalent. Both states go to the same next state (e, f) and have same output (0, 1).

- Therefore one state can be removed; **f** is replaced by **d.** The final reduced state table-2 is shown below.

Step2:Reduced State Table2:

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

Reduced state table-2

- Thus 7 states are reduced into 5 states.

3.Minimize the following state table.

Present state	Next state	
	X= 0	X= 1
A	D, 0	C, 1
B	E, 1	A, 1
C	H, 1	D, 1
D	D, 0	C, 1
E	B, 0	G, 1
F	H, 1	D, 1
G	A, 0	F, 1
H	C, 0	A, 1
I	G, 1	H,1

Soln:

Present state	Next state		Output	
	X= 0	X= 1	X= 0	X= 1
A	D	C	0	1
B	E	A	1	1
C	H	D	1	1
D	D	C	0	1
E	B	G	0	1
F	H	D	1	1
G	A	F	0	1
H	C	A	0	1
I	G	H	1	1

- From the above state table, **A** and **D** generate exactly same next state and same output for every possible set of inputs.
- The state **A** and **D** go to next states **D** and **C** and have outputs 0 and 1 for x=0 and x=1 respectively.
- Therefore state **D** can be removed and replaced by **A**. Similarly, **C** and **F** generate exactly same next state and same output for every possible set of inputs. The state **C** and **F** go to next states **H** and **D** and have outputs 1 and 1 for x=0 and x=1 respectively.
- Therefore state **F** can be removed and replaced by **C**.

Step1:Reduced state table-1:

Present state	Next state		Output	
	X= 0	X= 1	X= 0	X= 1
A	A	C	0	1
B	E	A	1	1
C	H	A	1	1
E	B	G	0	1
G	A	C	0	1
H	C	A	0	1
I	G	H	1	1

Reduced state table-1

- From the above reduced state table-1, **A** and **G** generate exactly same next state and same output for every possible set of inputs.
- The state **A** and **G** go to next states **A** and **C** and have outputs 0 and 1 for x=0 and x=1 respectively.
- Therefore state **G** can be removed and replaced by **A**. The final reduced state table-2 is shown below.

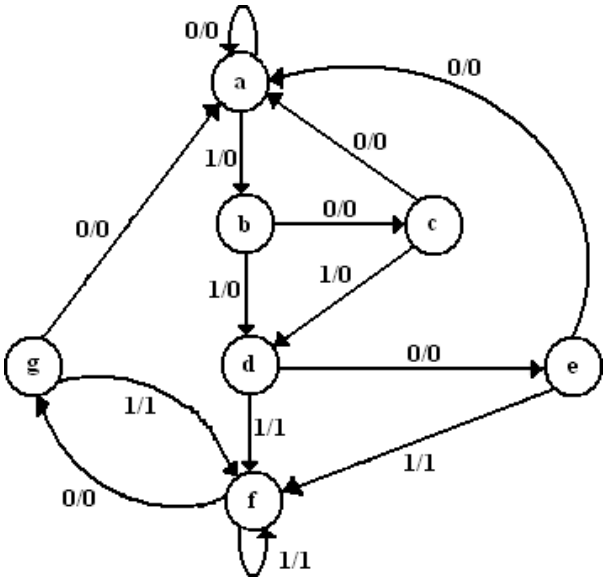
Step2:Reduced state table-2:

Present state	Next state		Output	
	X= 0	X= 1	X= 0	X= 1
A	A	C	0	1
B	E	A	1	1
C	H	A	1	1
E	B	A	0	1
H	C	A	0	1
I	A	H	1	1

Reduced state table-2

- Thus 9 states are reduced into 6 states.

4.Reduce the following state diagram.



Soln:

Step1:State table:

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

State table

- From the above state table **e** and **g** generate exactly same next state and same output for every possible set of inputs.
- The state **e** and **g** go to next states **a** and **f** and have outputs 0 and 1 for x=0 and x=1 respectively.
- Therefore state **g** can be removed and replaced by **e**.

Step2: Reduced state table-1

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

Reduced state table-1

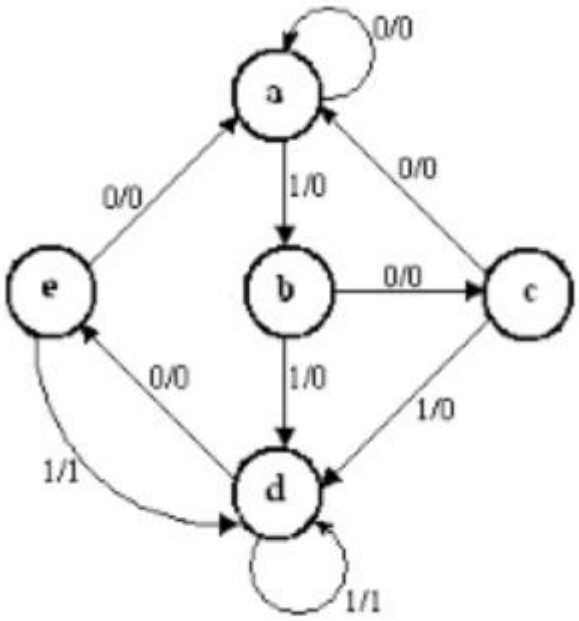
- Now states d and f are equivalent. Both states go to the same next state (e, f) and have same output (0, 1).
- Therefore one state can be removed; **f** is replaced by **d.**

Step3: Reduced state table-2

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

- Thus 7 states are reduced into 5 states.

Step4: State Diagram



Reduced state diagram