Asynchronous Sequential Logic

LECTURE 5

- **Reduction of State and Flow Tables**
- **Race-Free State Assignment**

Dronacharya Group of Institutions

Reduction of State and Flow Tables

Equivalent States

Two states are equivalent if for each possible input, they give exactly the same output and go to the same next states or to equivalent next states.

The characteristic of equivalent states is that if (a,b) imply (c,d) and (c,d) imply (a,b), then both pairs of states are equivalent.

Reduction of State and Flow Tables

Implication Table

Two states are equivalent if for each possible input, they give exactly the same output and go to the same next states or to equivalent next states.

The characteristic of equivalent states is that if (*a*,*b*) imply (*c*,*d*) and (*c*,*d*) imply (*a*,*b*), then both pairs of states are equivalent.

Reduction of State and Flow Tables

Implication Table

Example

S_n \ X_1X_2	00	01	11	10
A	D/0	D/0	F/0	A/0
B	C/1	D/0	E/1	F/0
C	C/1	D/0	E/1	A/0
D	D/0	B/0	A/0	F/0
E	C/1	F/0	E/1	A/0
F	D/0	D/0	A/0	F/0
G	G/0	G/0	A/0	A/0
H	B/1	D/0	E/1	A/0

S_{n+1}/Z_n

Without the first

Without the last

	A	B	C	D	E	F	G
B	×						
C	×	AF					
D	BD AF	×	×				
E	×	DF AF	DF	×			
F	√	×	×	BD	×		
G	DG AF	×	×	BG AF	×	DG AF	
H	×	BC AF	BC	×	BC DF	×	×

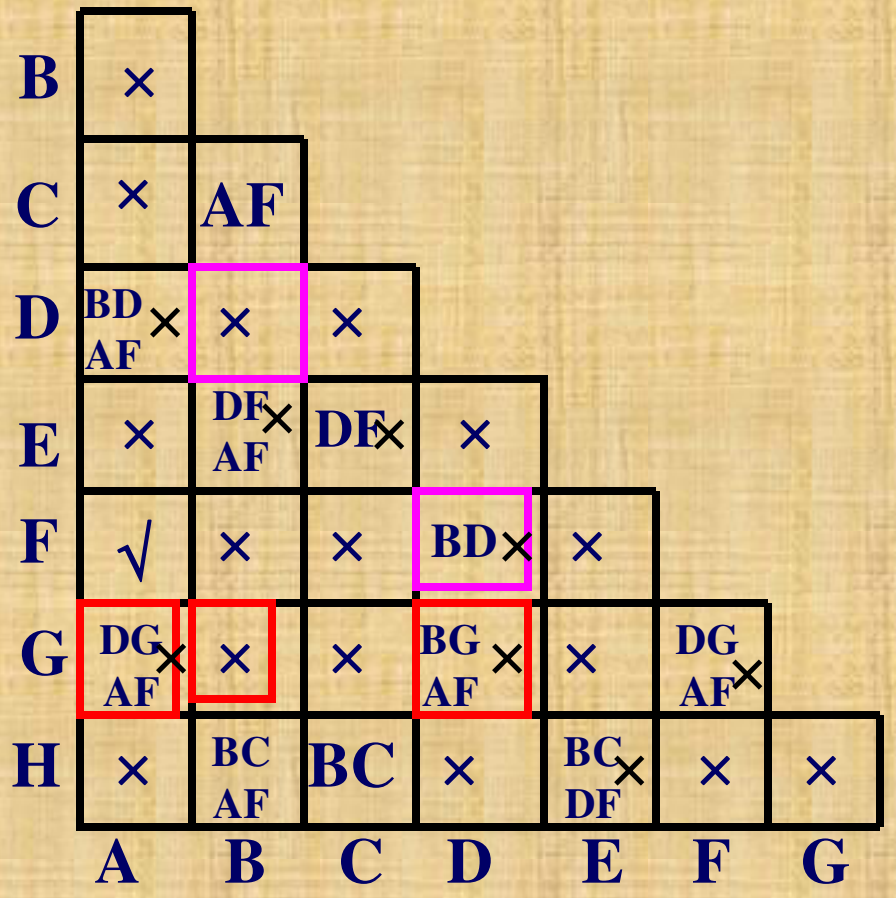
Reduction of State and Flow Tables

Implied Pairs

example

S_n \ X_1X_2	00	01	11	10
A	D/0	D/0	F/0	A/0
B	C/1	D/0	E/1	F/0
C	C/1	D/0	E/1	A/0
D	D/0	B/0	A/0	F/0
E	C/1	F/0	E/1	A/0
F	D/0	D/0	A/0	F/0
G	G/0	G/0	A/0	A/0
H	B/1	D/0	E/1	A/0

S_{n+1}/Z_n



Reduction of State and Flow Tables

The equivalent states：[A，F]、[B，H]、[B，C]、[C，H]。

The largest group of equivalent states

[A，F], [B，C，H], [D], [E], [G]

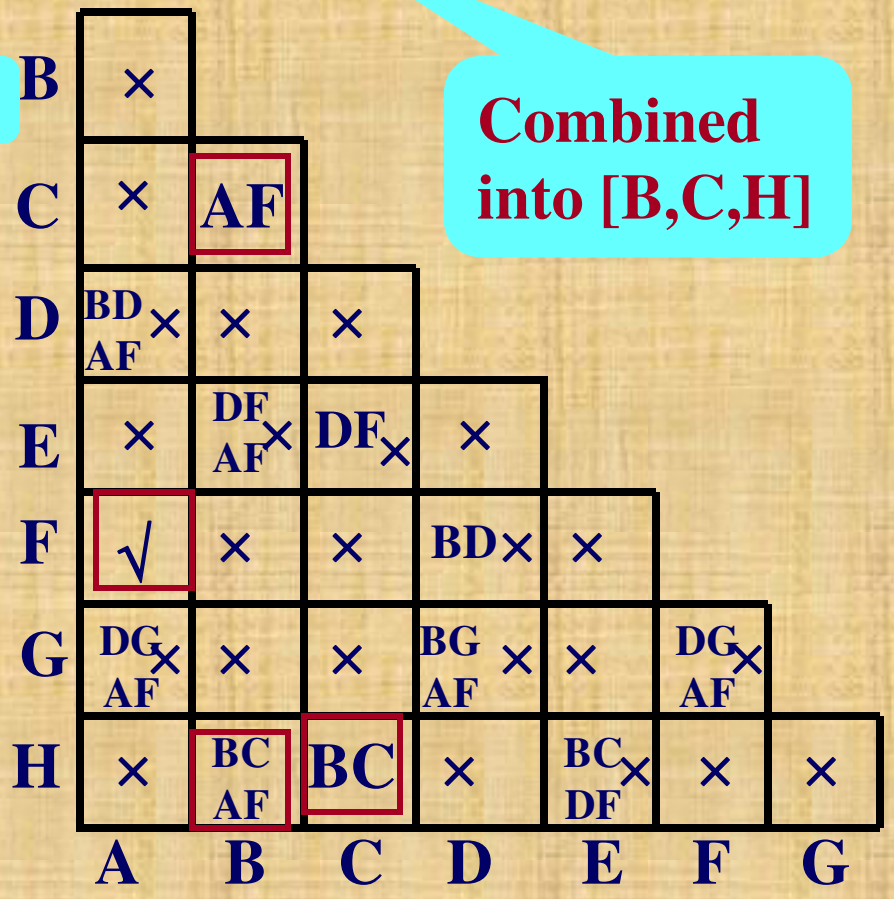
Denoted by A

Denoted by B

Combined into [B,C,H]

S_n \ X_1X_2	00	01	11	10
A	D/0	D/0	A/0	A/0
B	C/1	D/0	E/1	A/0
D	D/0	B/0	A/0	A/0
E	B/1	A/0	E/1	A/0
G	G/0	G/0	A/0	A/0

S_{n+1}/Z_n



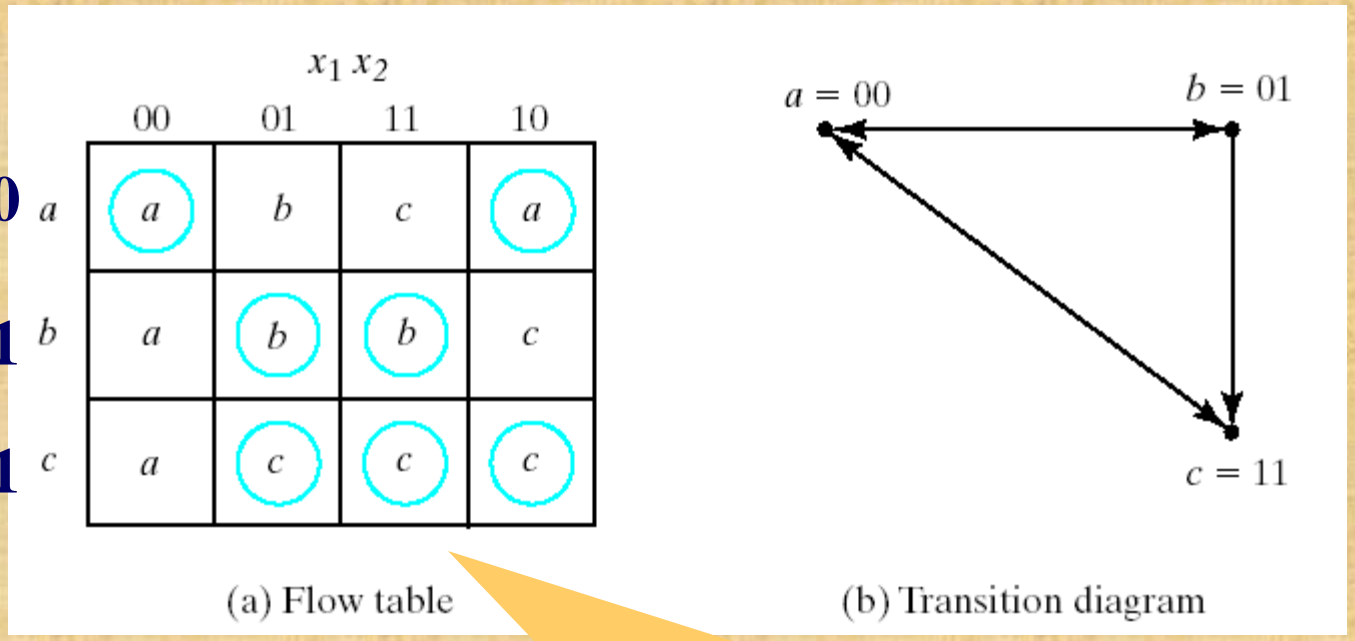
Race-Free State Assignment

The primary objective in choosing a proper binary state assignment is the prevention of critical races.

Critical races can be avoided by making a binary state assignment in such a way that only one variable changes at any given time when a state transition occurs in the flow table.

Race-Free State Assignment

Three-Row Flow-Table Example



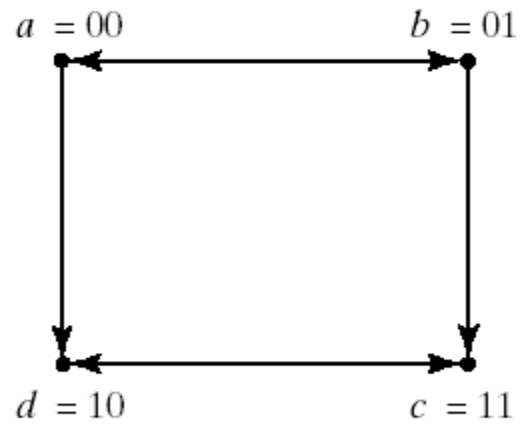
This assignment will cause a critical race during the transition from *a* to *c*.

Race-Free State Assignment

Three-Row Flow-Table Example

		x_1x_2 = 00	01	11	10
00	*a*	(*a*)	*b*	*d*	(*a*)
01	*b*	*a*	(*b*)	(*b*)	*c*
11	*c*	*d*	(*c*)	(*c*)	(*c*)
10	*d*	*a*	–	*c*	–

(a) Flow table

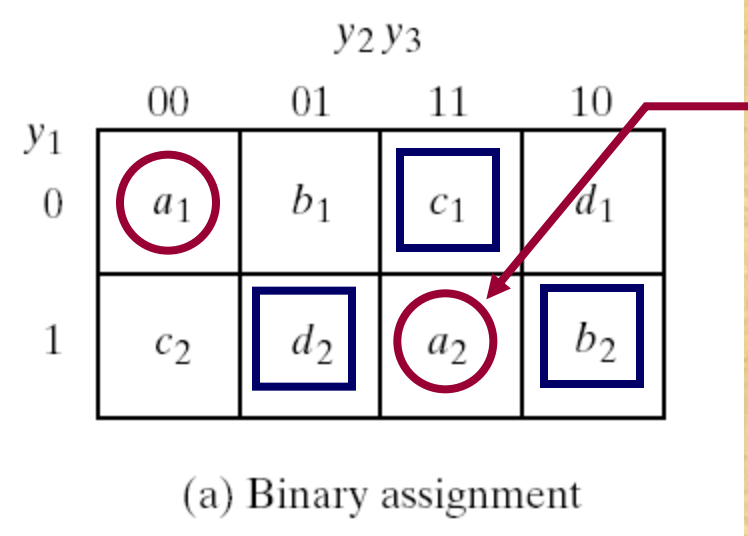


The transition from *a* to *c* must now go through *d*, thus avoiding a critical race.

Race-Free State Assignment

Multiple-Row Method

In the multiple-row assignment, each state in the original flow table is replaced by two or more combinations of state variables.



(a) Binary assignment

Note that a2 is adjacent to d2, c1, b2.

Race-Free State Assignment

Multiple-Row Method

	00	01	11	10
a	b	a	d	a
b	b	d	b	a
c	c	a	b	c
d	c	d	d	c

(a) Flow table

The original flow table

	00	01	11	10
$000 = a_1$	b_1	a_1	d_1	a_1
$111 = a_2$	b_2	a_2	d_2	a_2
$001 = b_1$	b_1	d_2	b_1	a_1
$110 = b_2$	b_2	d_1	b_2	a_2
$011 = c_1$	c_1	a_2	b_1	c_1
$100 = c_2$	c_2	a_1	b_2	c_2
$010 = d_1$	c_1	d_1	d_1	c_1
$101 = d_2$	c_2	d_2	d_2	c_2

(b) Flow table