SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

1EC306 Digital Electronics

AB \ CD	00	01	11	10
00				
01			0	0
11	X	X	X	X
10	0	0	X	X

AB \ CD	00	01	11	10
00	1 (0)	0 (1)	0 (3)	1 (2)
01	0 (4)	1 (5)	1 (7)	0 (6)
11	0 (12)	1 (13)	1 (15)	0 (14)
10	1 (8)	0 (9)	0 (11)	1 (10)

Guess today's topic???

Karnaugh Map

- Feel a little difficult using Boolean algebra laws, rules, and theorems to simplify logic?
- A K-map provides a systematic method for simplifying Boolean expressions and, if properly used, will produce the simplest SOP or POS expression possible, known as the minimum expression.

What is K-map?

- It's similar to truth table; instead of being organized (i/p and o/p) into columns and rows, the K-map is an array of cells in which each cell represents a binary value of the input variables.
- The cells are arranged in a way so that simplification of a given expression is simply a matter of properly grouping the cells.
- K-maps can be used for expressions with 2, 3, 4, and 5 variables.
  - 3 and 4 variables will be discussed to illustrate the principles.

3 variable K-Map

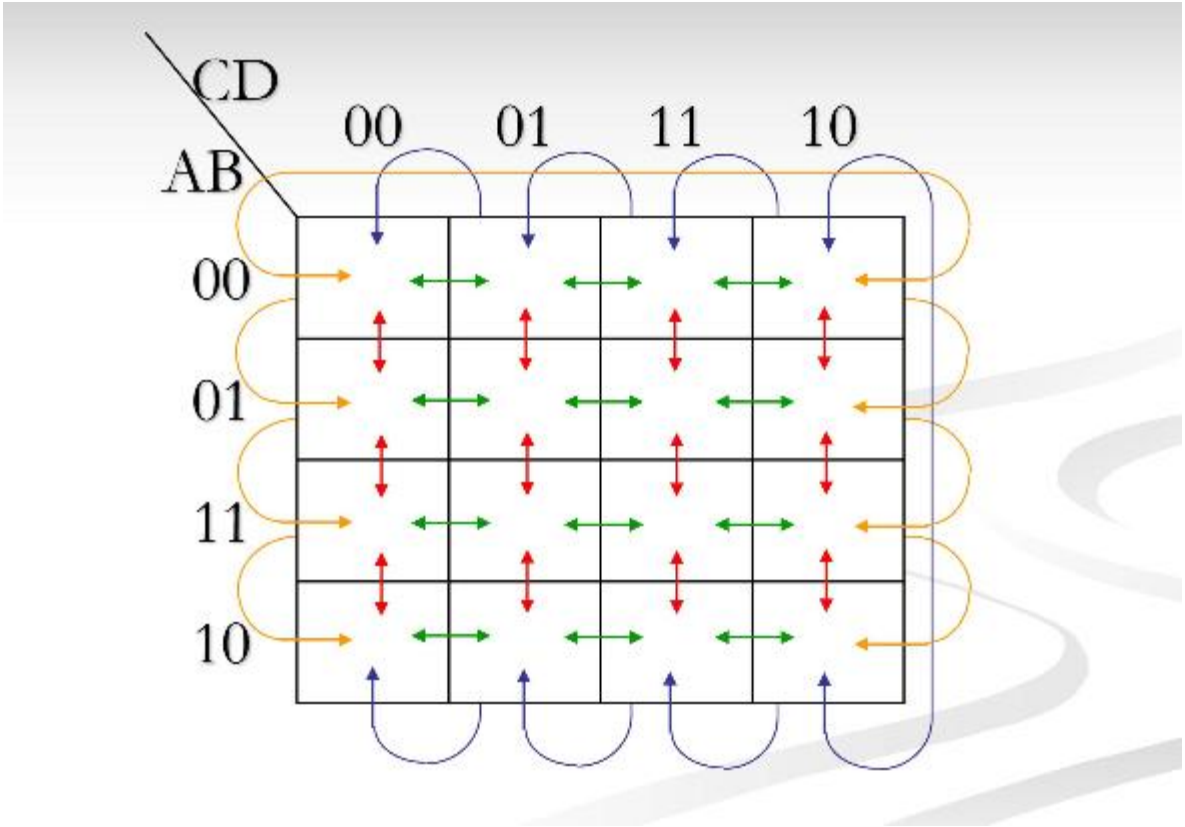
- There are 8 cells as shown:

AB \ C	0	1
00	$\overline{A}\,\overline{B}\,\overline{C}$	$\overline{A}\,\overline{B}\,C$
01	$\overline{A}\,B\,\overline{C}$	$\overline{A}\,BC$
11	$AB\,\overline{C}$	ABC
10	$A\,\overline{B}\,\overline{C}$	$A\,\overline{B}\,C$

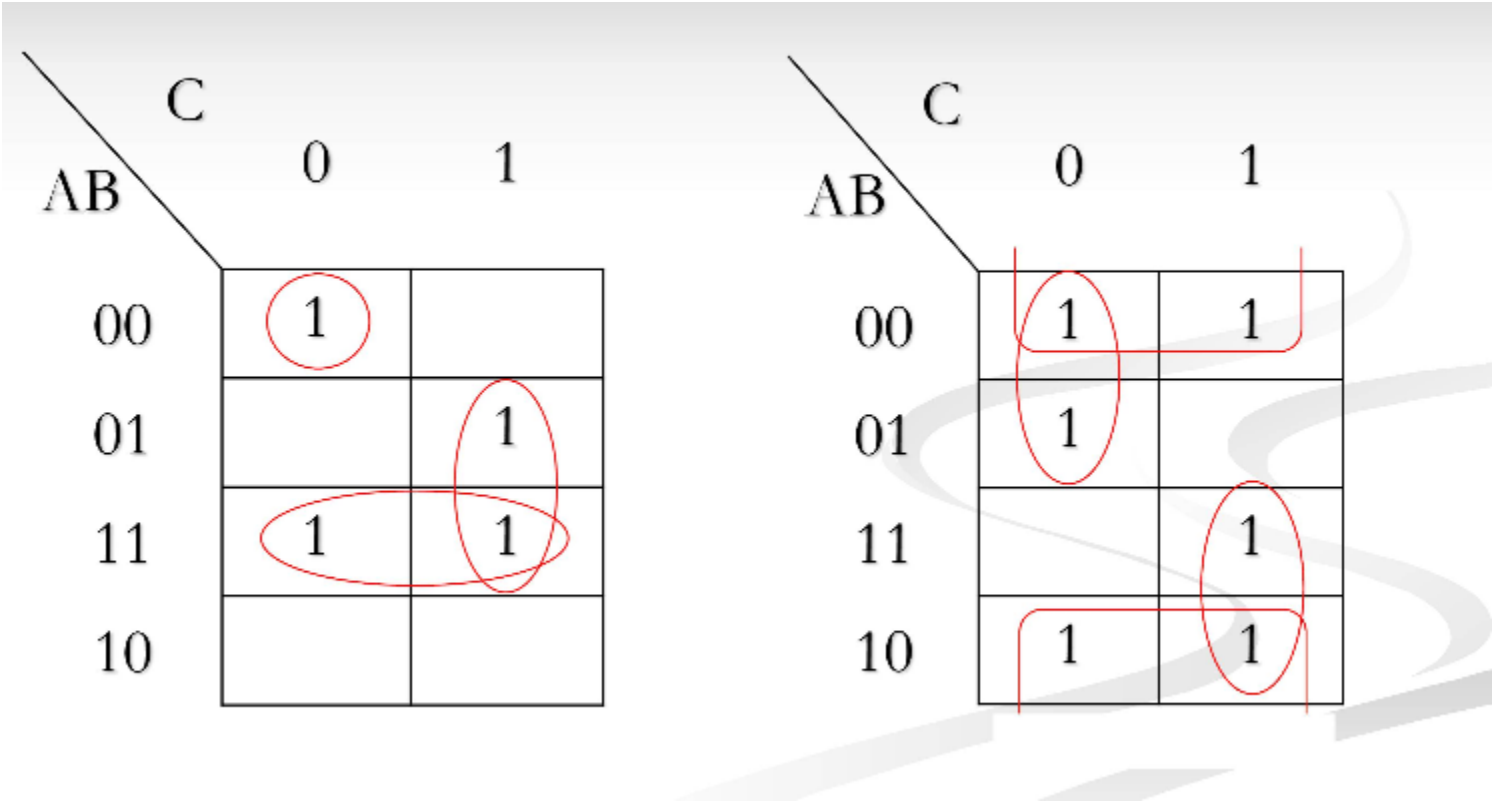
4 variable K-Map

AB \ CD	00	01	11	10
00	$\bar{A}\bar{B}\bar{C}\bar{D}$	$\bar{A}\bar{B}\bar{C}D$	$\bar{A}\bar{B}CD$	$\bar{A}\bar{B}C\bar{D}$
01	$\bar{A}B\bar{C}\bar{D}$	$\bar{A}B\bar{C}D$	$\bar{A}BCD$	$\bar{A}BC\bar{D}$
11	$AB\bar{C}\bar{D}$	$AB\bar{C}D$	$ABCD$	$ABC\bar{D}$
10	$A\bar{B}\bar{C}\bar{D}$	$A\bar{B}\bar{C}D$	$A\bar{B}CD$	$A\bar{B}C\bar{D}$

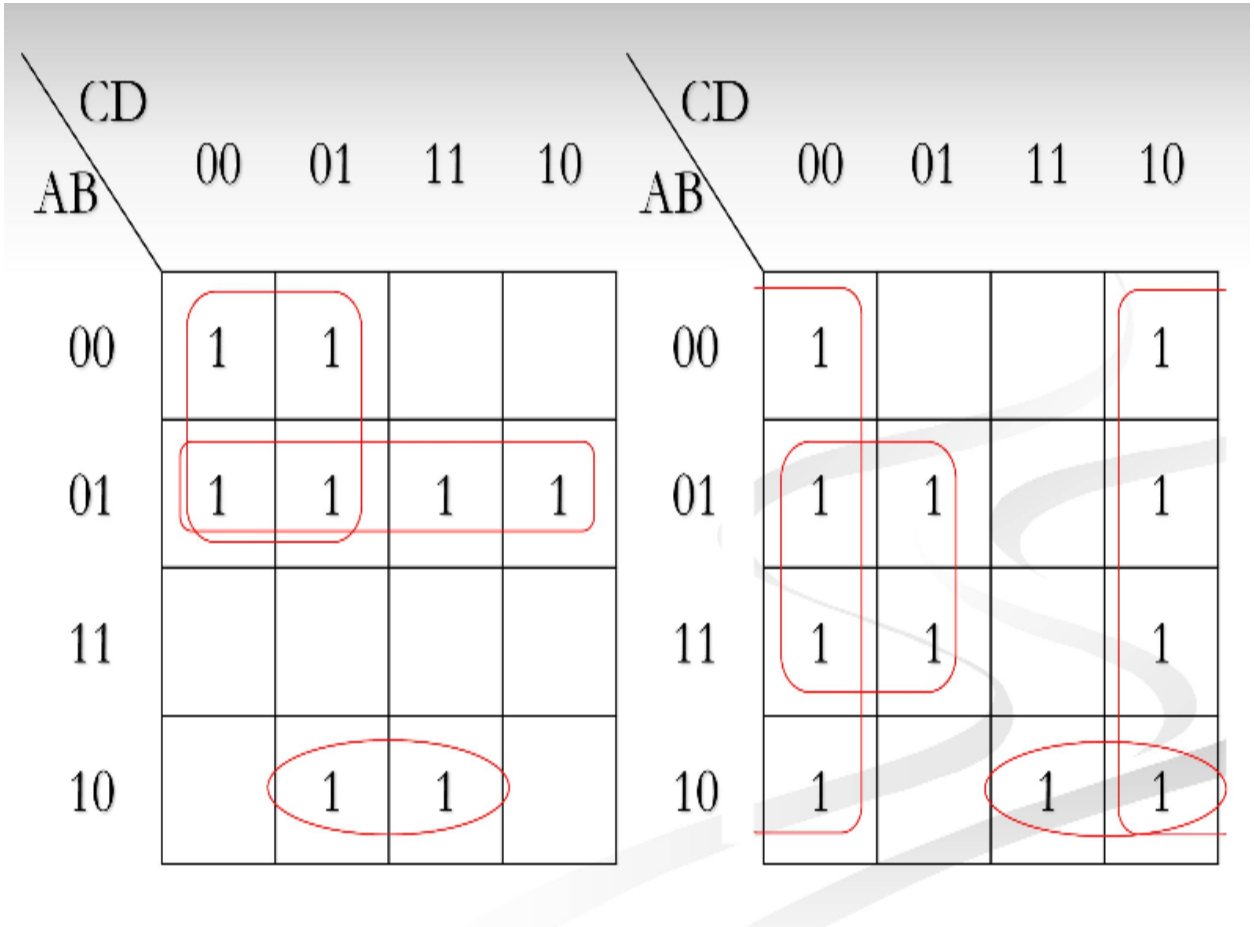
Cell adjacency



Grouping the 1's Example



Grouping the 1's Example

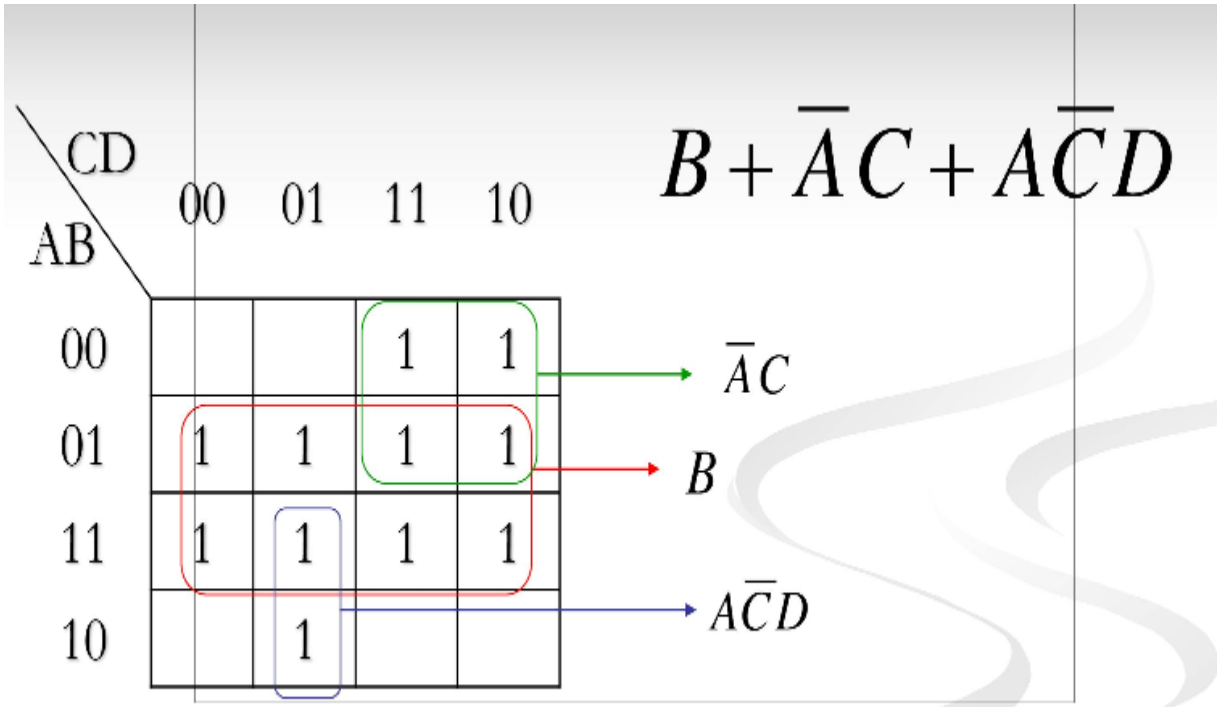


Determining the minimum SOP

Determine the minimum product term for each group.

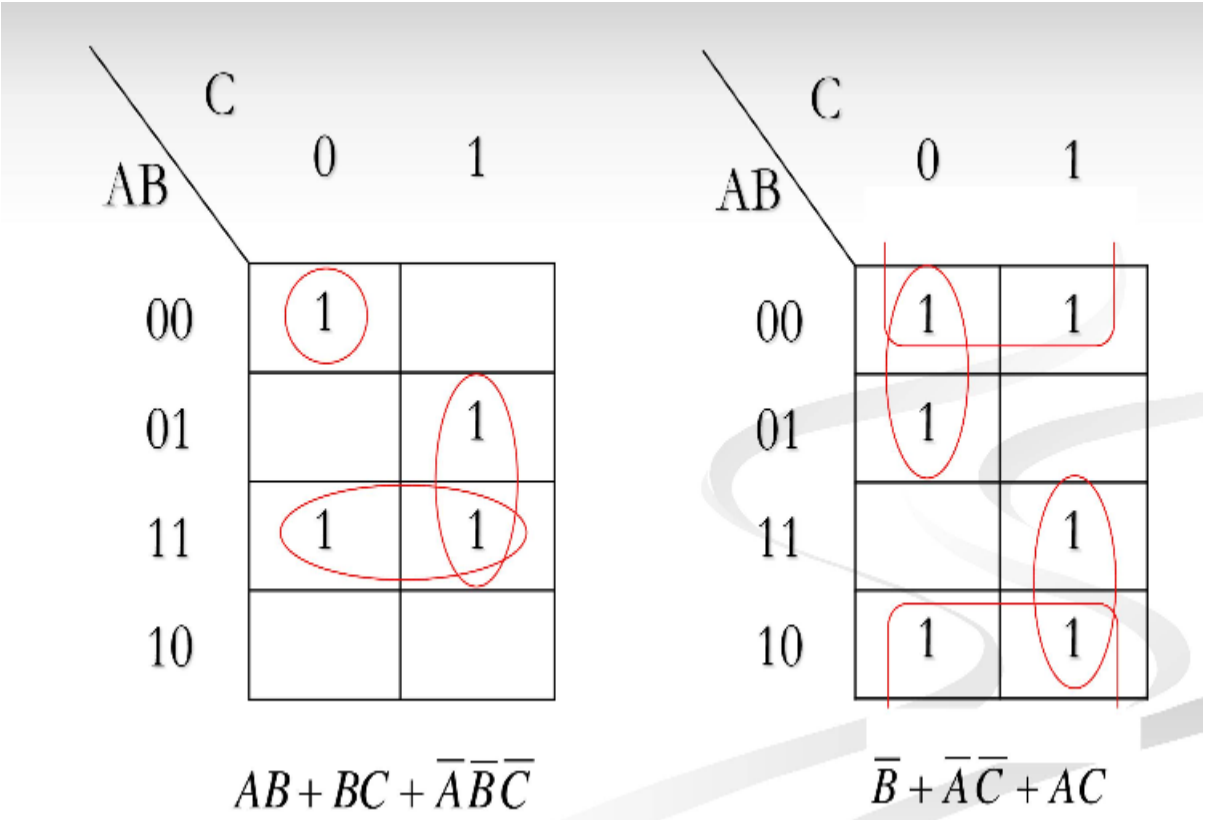
- For a 3-variable map:
  1. A 1-cell group yields a 3-variable product term
  2. A 2-cell group yields a 2-variable product term
  3. A 4-cell group yields a 1-variable product term
  4. An 8-cell group yields a value of 1 for the expression.
- For a 4-variable map:
  1. A 1-cell group yields a 4-variable product term
  2. A 2-cell group yields a 3-variable product term
  3. A 4-cell group yields a 2-variable product term
  4. An 8-cell group yields a a 1-variable product term
  5. A 16-cell group yields a value of 1 for the expression.

State Reduction

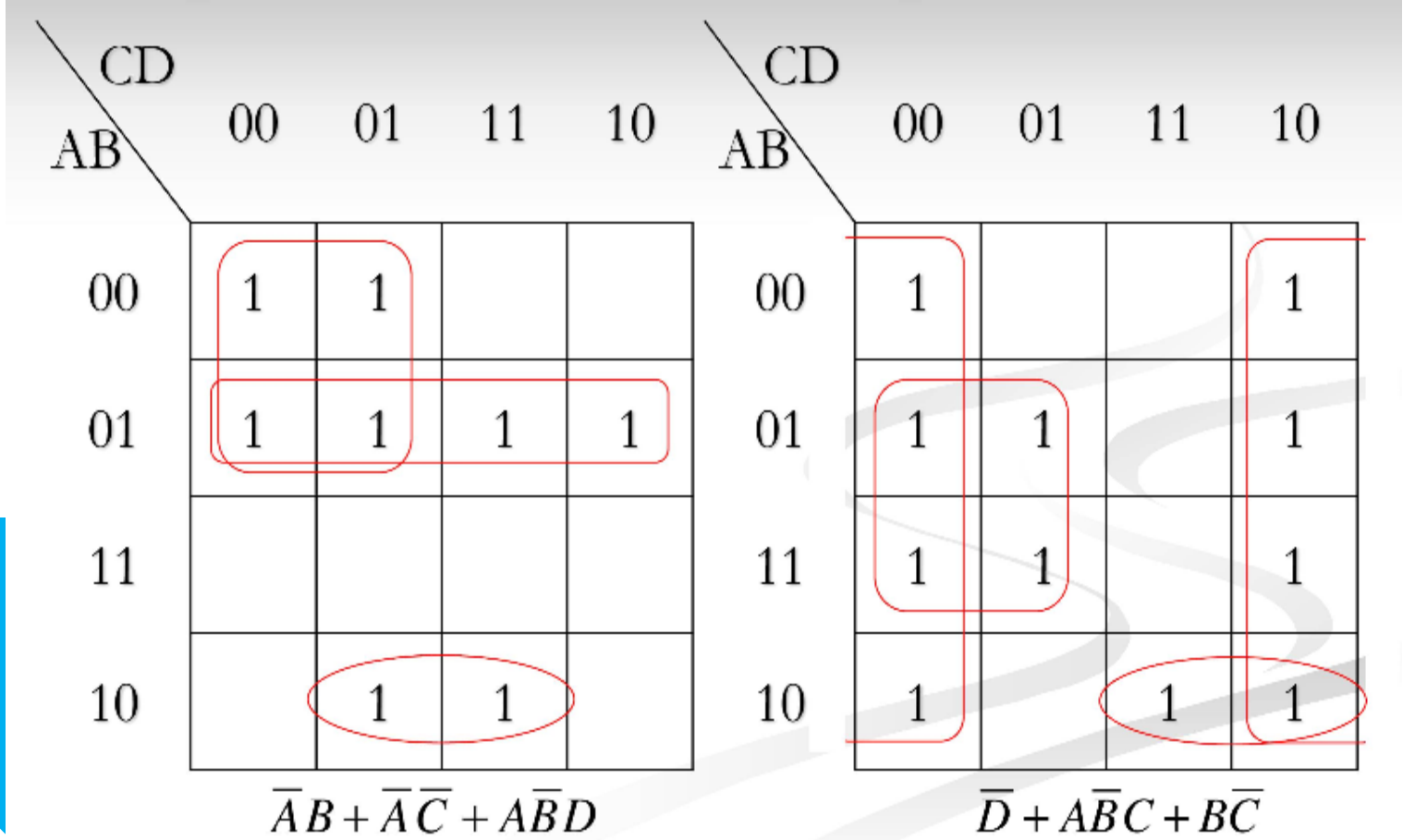


$$B + \bar{A}C + A\bar{C}D$$

State Reduction

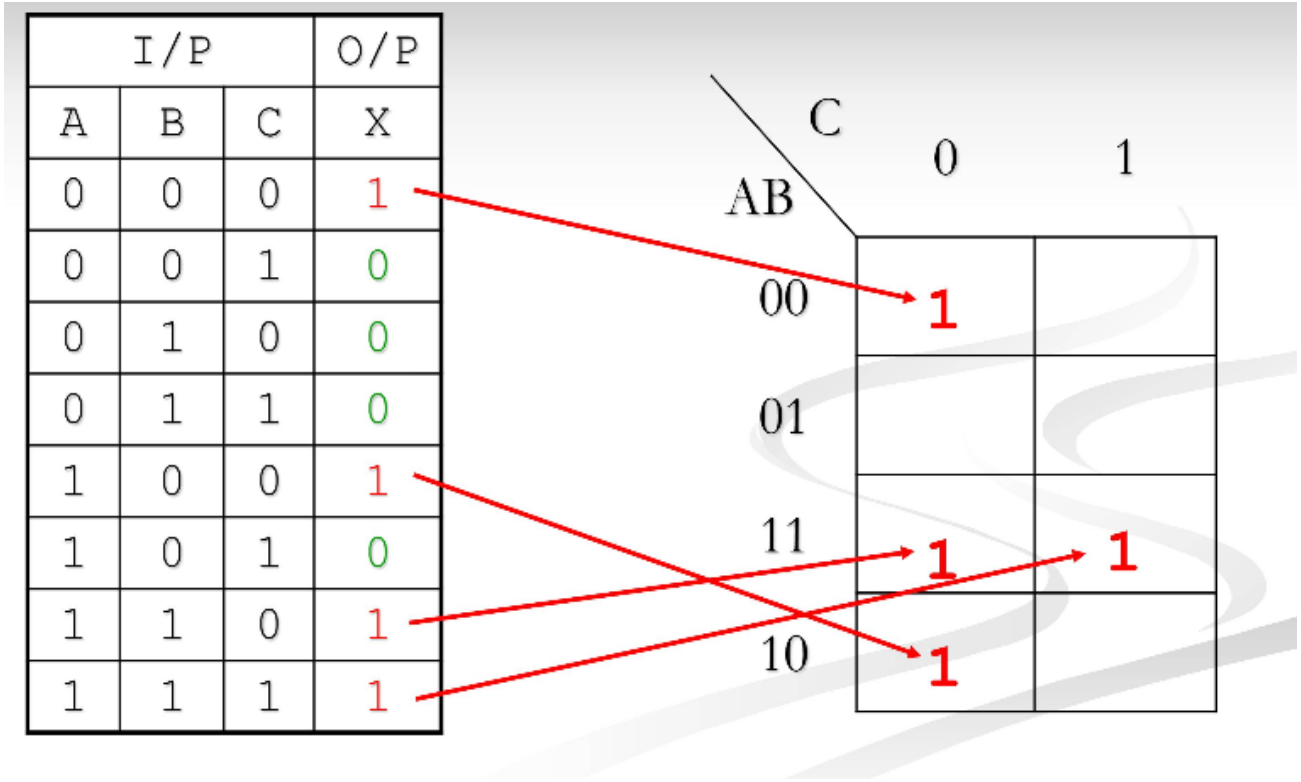


State Reduction



Mapping Directly from a Truth Table

I/P			O/P
A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

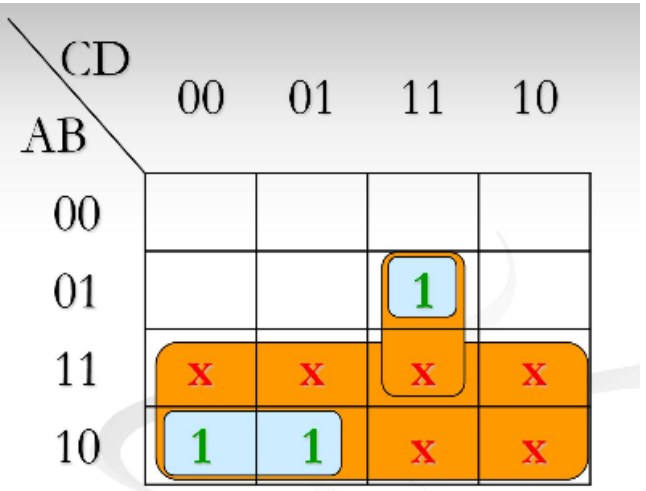


Don’t care condition

- Sometimes a situation arises in which some input variable combinations are not allowed, i.e. BCD code:
  - There are six invalid combinations: 1010, 1011, 1100, 1101, 1110, and 1111.
- Since these unallowed states will never occur in an application involving the BCD code → they can be treated as “don’t care” terms with respect to their effect on the output.
- The “don’t care” terms can be used to advantage on the K-map (how? see the next slide).

Don’t care condition-Assessment

INPUTS				O/P
A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X



Without “don’t care”

$$Y = A\bar{B}\bar{C} + \bar{A}BCD$$

With “don’t care”

$$Y = A + BCD$$


Thank You!