# SNS COLLEGE OF TECHNOLOGY

**An Autonomous Institution**

**Coimbatore-35**

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A++' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

## 23ECB221 – DIGITAL ELECTRONICS

II YEAR/ III SEMESTER

## UNIT 1 – MINIMIZATION TECHNIQUES AND LOGIC GATES

TOPIC – KARNAUGH MAP

# KARNAUGH MAP

- The Karnaugh map technique provides a systematic method for simplifying and manipulation of Boolean expressions.
- A K-map is a diagram made up of squares, with each square representing one min term of the function that is to be minimized. For *n* variables on a Karnaugh map there are $2^n$ numbers of squares.
- Each square or cell represents one of the min terms. It can be drawn directly from either min term (sum-of- products) or max term (product-of-sums) Boolean expressions.

# KARNAUGH MAP

## Two- Variable, Three Variable and Four Variable Maps

- Karnaugh maps can be used for expressions with two, three, four and five variables. The number of cells in a Karnaugh map is equal to the total number of possible input variable combinations as is the number of rows in a truth table.
- For three variables, the number of cells is $2^3 = 8$. For four variables, the number of cells is $2^4 = 16$.

# KARNAUGH MAP VARIABLES

| A | $\bar{A}$ |
|---|---|
| $\bar{A}$ | $\bar{A}$ |
| A | A |

1-Variable map

| A \ B | $\bar{B}$ | B |
|---|---|---|
| $\bar{A}$ | $\bar{A}\bar{B}$ | $\bar{A}B$ |
| A | $A\bar{B}$ | AB |

2-Variable map

| A \ BC | $\bar{B}\bar{C}$ | $\bar{B}C$ | BC | $B\bar{C}$ |
|---|---|---|---|---|
| $\bar{A}$ | $\bar{A}\bar{B}\bar{C}$ | $\bar{A}\bar{B}C$ | $\bar{A}BC$ | $\bar{A}B\bar{C}$ |
| A | $A\bar{B}\bar{C}$ | $A\bar{B}C$ | ABC | $AB\bar{C}$ |

3-Variable map

| AB \ CD | $\bar{C}\bar{D}$ | $\bar{C}D$ | CD | $C\bar{D}$ |
|---|---|---|---|---|
| $\bar{A}\bar{B}$ | $\bar{A}\bar{B}\bar{C}\bar{D}$ | $\bar{A}\bar{B}\bar{C}D$ | $\bar{A}\bar{B}CD$ | $\bar{A}\bar{B}C\bar{D}$ |
| $\bar{A}B$ | $\bar{A}B\bar{C}\bar{D}$ | $\bar{A}B\bar{C}D$ | $\bar{A}BCD$ | $\bar{A}BC\bar{D}$ |
| AB | $AB\bar{C}\bar{D}$ | $AB\bar{C}D$ | ABCD | $ABC\bar{D}$ |
| $A\bar{B}$ | $A\bar{B}\bar{C}\bar{D}$ | $A\bar{B}\bar{C}D$ | $A\bar{B}CD$ | $A\bar{B}C\bar{D}$ |

4-Variable map

# KARNAUGH MAP VARIABLES

| A \ 0 |
|---|
| 0 | $m_0$ |
| 1 | $m_1$ |

1 -Variable map

| A \ B | 0 | 1 |
|---|---|---|
| 0 | $m_0$ | $m_1$ |
| 1 | $m_2$ | $m_3$ |

2 -Variable map

Gray code Sequence →

| A \ BC | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | $m_0$ | $m_1$ | $m_3$ | $m_2$ |
| 1 | $m_4$ | $m_5$ | $m_7$ | $m_6$ |

3 -Variable map

Gray code Sequence →

Gray code Sequence ↓

| AB \ CD | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | $m_0$ | $m_1$ | $m_3$ | $m_2$ |
| 01 | $m_4$ | $m_5$ | $m_7$ | $m_6$ |
| 11 | $m_{12}$ | $m_{13}$ | $m_{15}$ | $m_{14}$ |
| 10 | $m_8$ | $m_9$ | $m_{11}$ | $m_{10}$ |

4- Variable map

# KARNAUGH MAP GROUPING

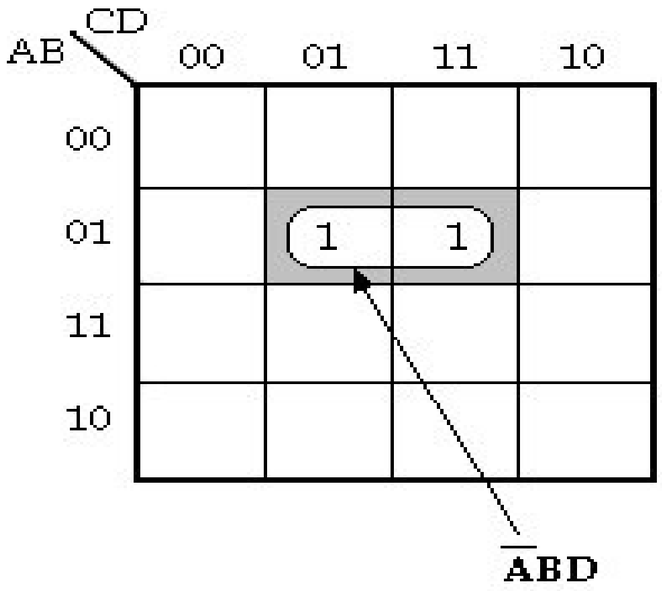
## Grouping cells for Simplification:

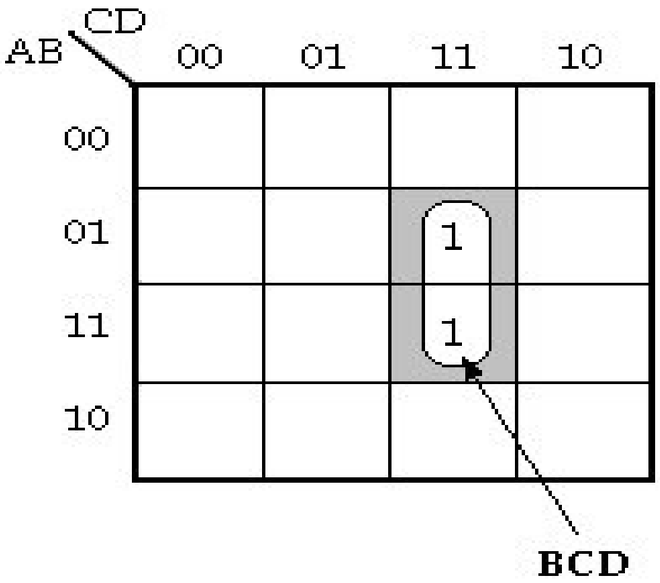
- The grouping is nothing but combining terms in adjacent cells. The simplification is achieved by grouping adjacent 1’s or 0’s in groups of 2i, where i = 1, 2, …, n and n is the number of variables.
- When adjacent 1’s are grouped then we get result in the sum of product form; otherwise we get result in the product of sum form.

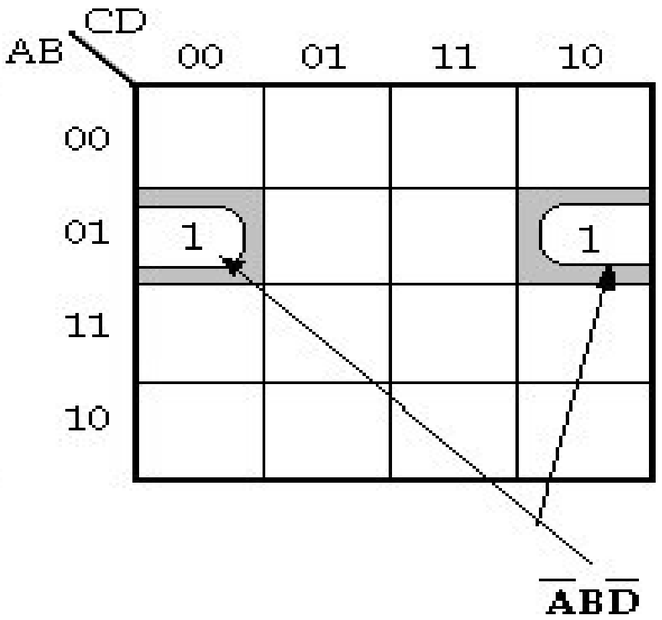
# KARNAUGH MAP GROUPING

## Grouping Two Adjacent 1's: (Pair)

In a Karnaugh map we can group two adjacent 1's. The resultant group is called Pair.



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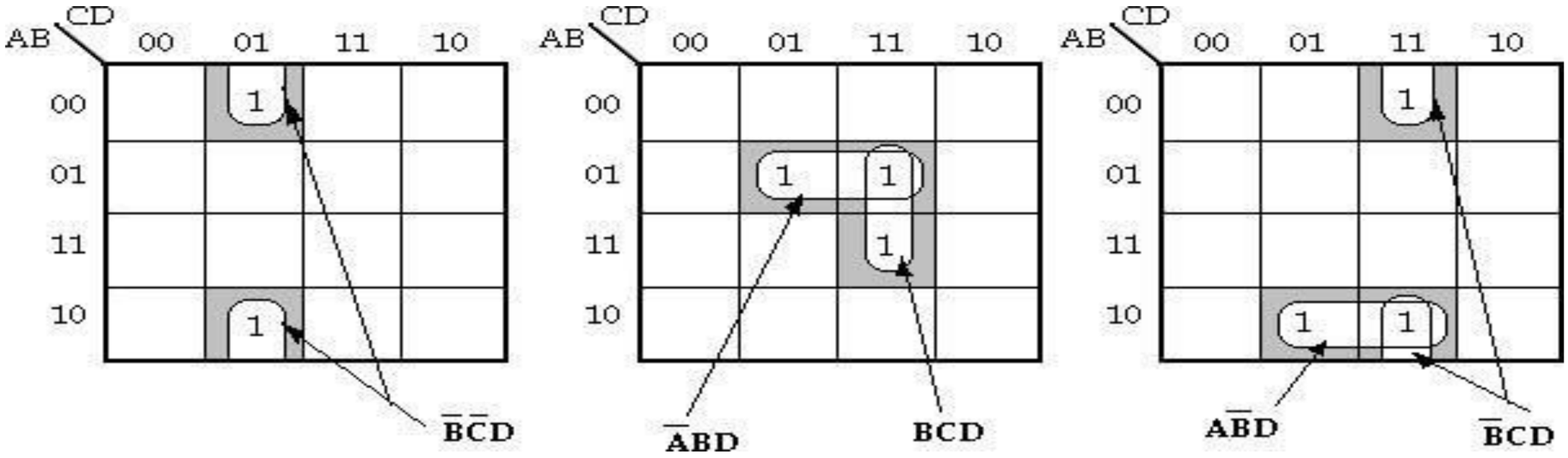
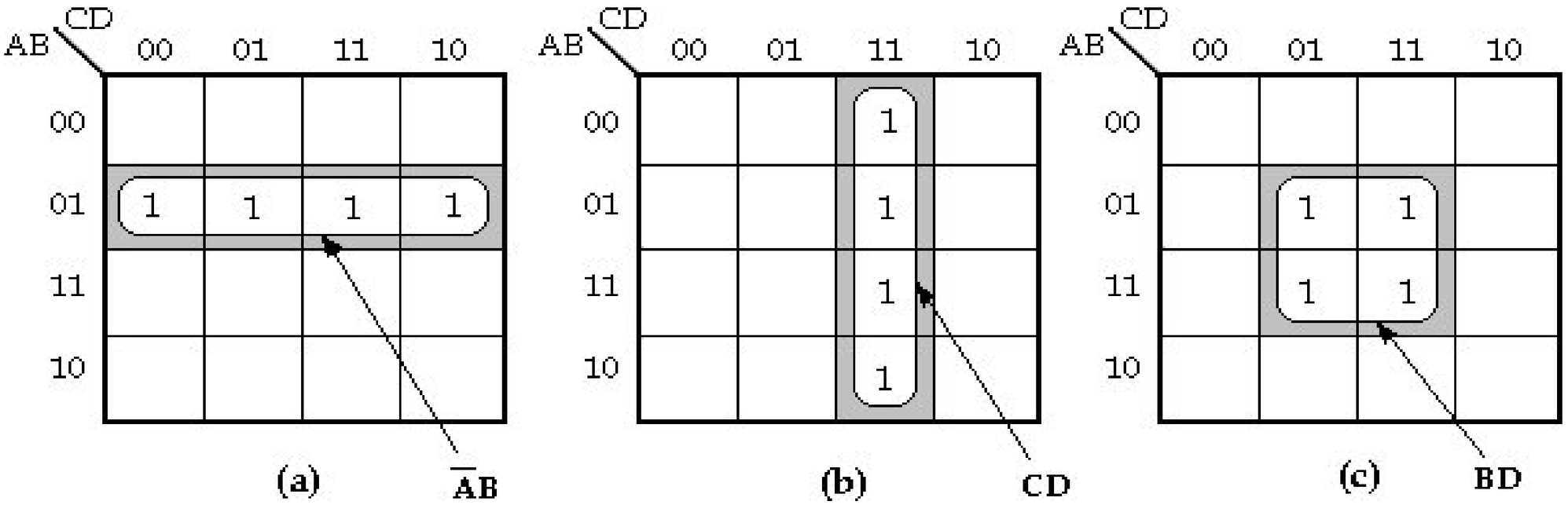


# KARNAUGH MAP GROUPING

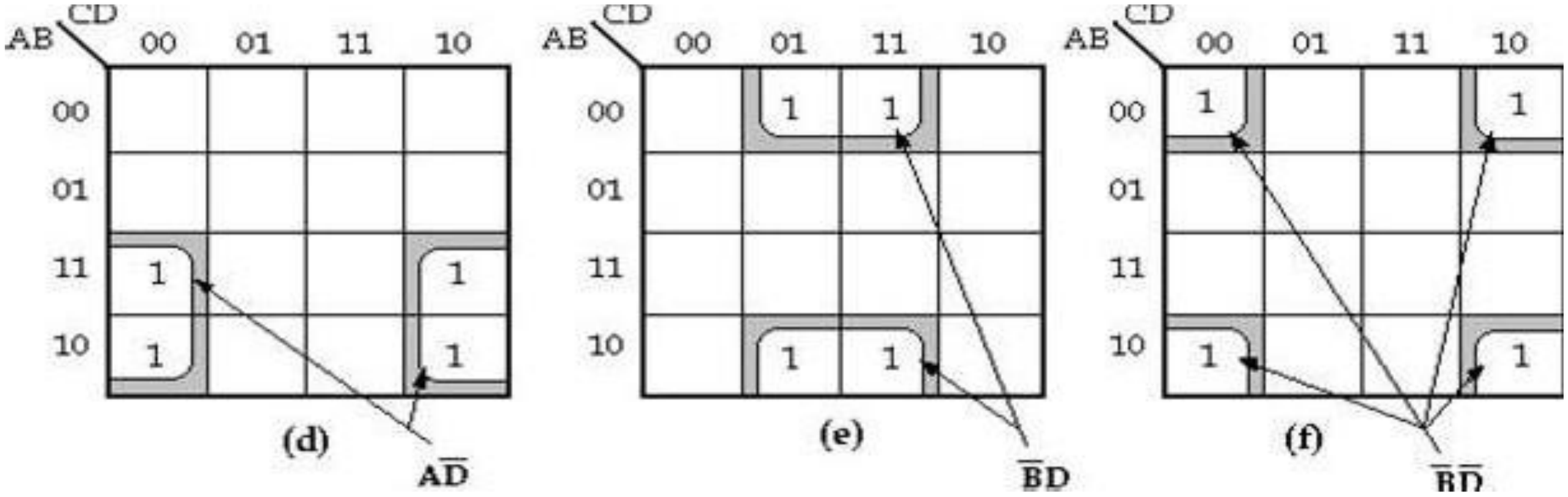
## Grouping Four Adjacent 1's: (Quad)

In a Karnaugh map we can group four adjacent 1's. The resultant group is called Quad.



## Grouping Four Adjacent 1's: (Quad)

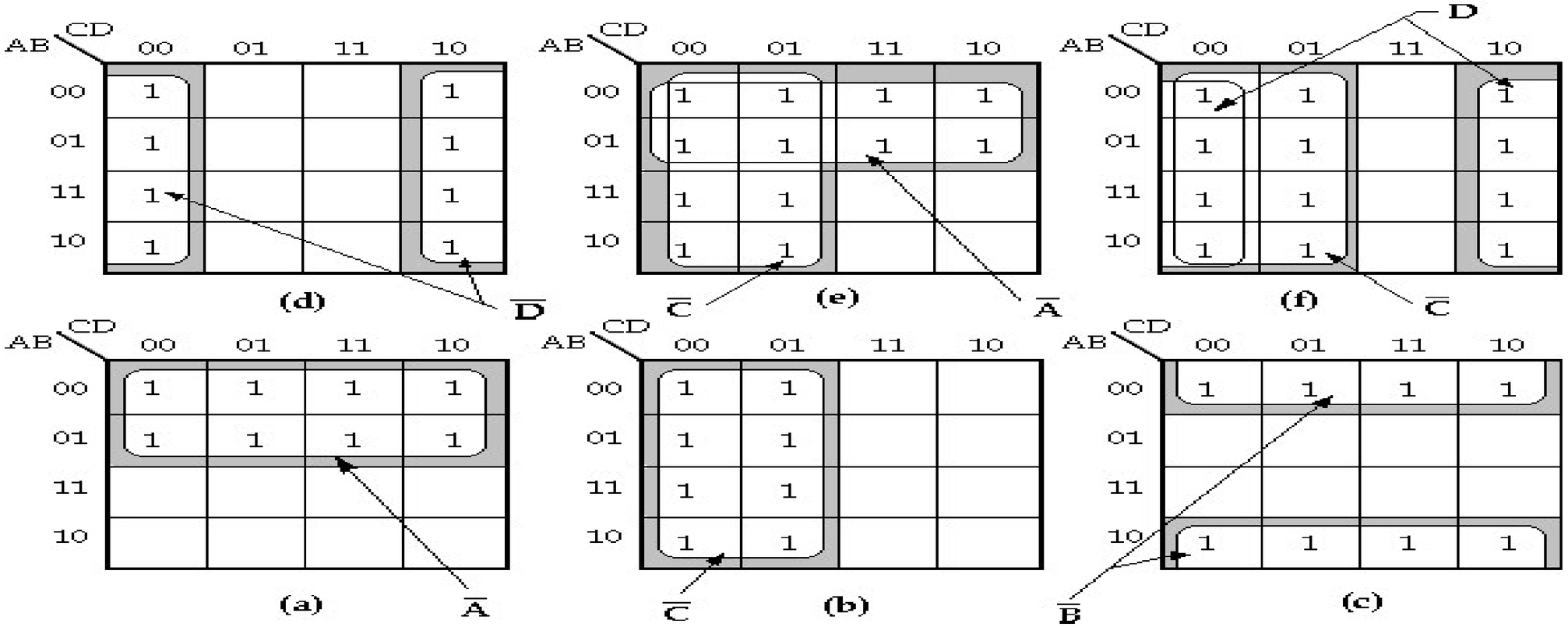
In a Karnaugh map we can group four adjacent 1's. The resultant group is called Quad.



# KARNAUGH MAP GROUPING

## Grouping Eight Adjacent 1's: (Octet)

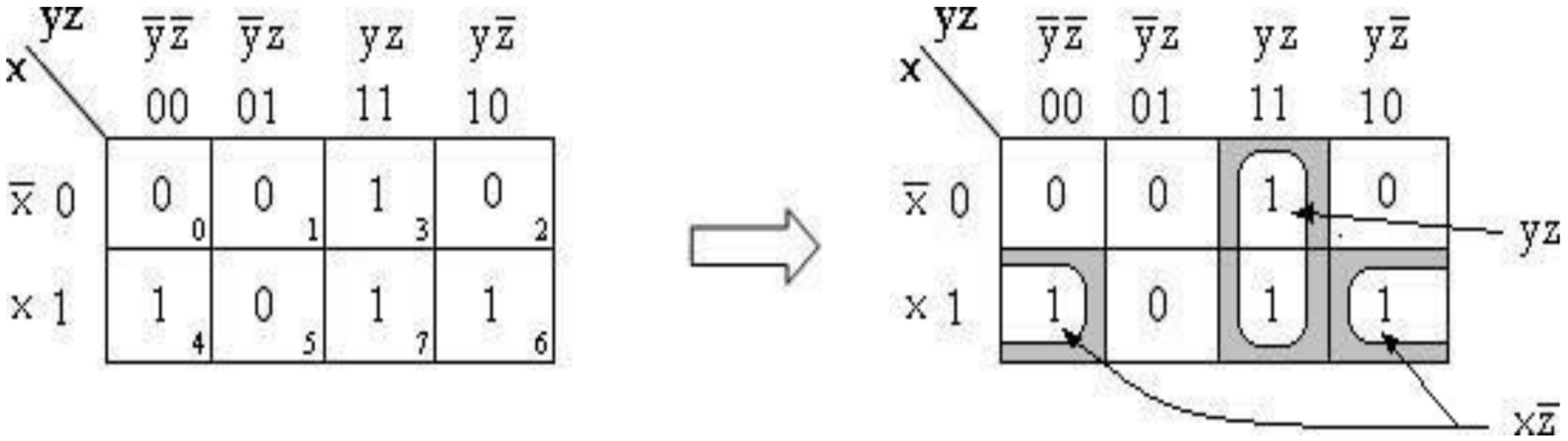
In a Karnaugh map we can group eight adjacent 1's. The resultant group is called Octet.



# KARNAUGH MAP PROBLEMS

Simplify the Boolean expression,

**F(x, y, z) = ∑m (3, 4, 6, 7).**



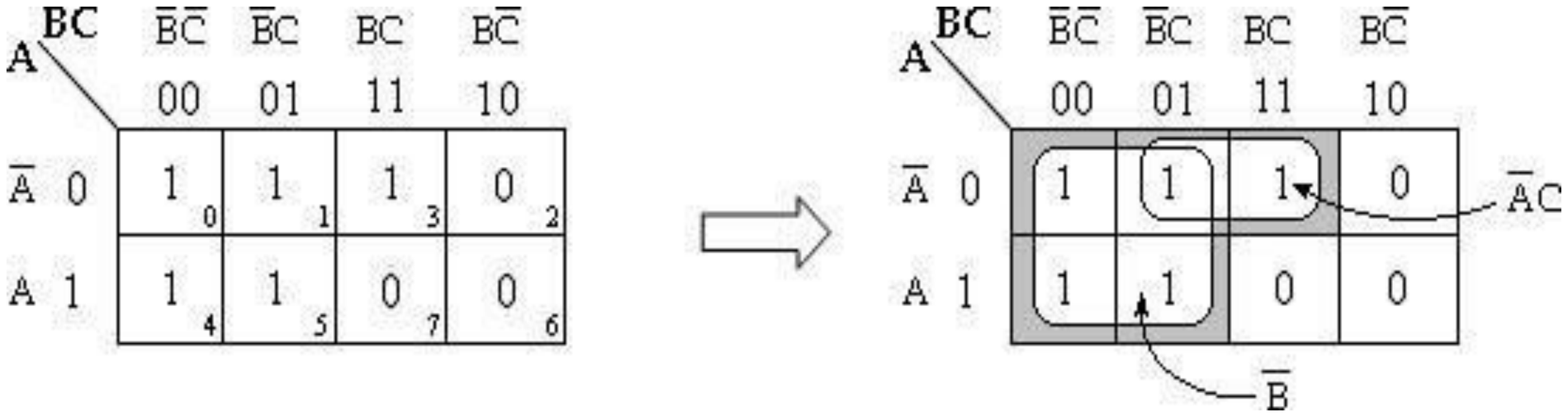

**F = yz+ xz'**

# KARNAUGH MAP PROBLEMS

**AB'C + A'B'C + A'BC + AB'C' + A'B'C'**

= m5 + m1 + m3 + m4 + m0

= ∑ m (0, 1, 3, 4, 5)




**F = A'C+B'**

# ASSESSMENT

1. Define Karnaugh Map.
2. What is meant by Quad in K-Map Variable.
3. List the Variables of Karnaugh Map.
4. Group of Four adjacent 1's is called ----------
5. In a Karnaugh map we can group eight adjacent 1's. The resultant group is called ----------
6. For three variables, the number of cells is $2^3$ = ---------- . For four variables, the number of cells is $2^4$ = ----------
7. Simplify the Boolean expression:

   **Y = A'BC'D' + A'BC'D + ABC'D' + ABC'D + AB'C'D + A'B'CD'**

# THANK YOU