ASSIGNMENT-06

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Course : CSE231

Section : 10

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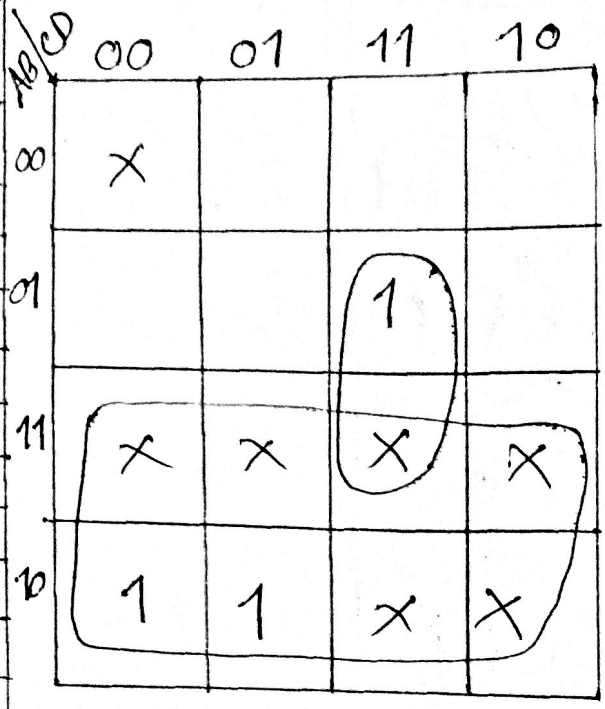
Digital Logic Design

"Don't care" condition:

use of "don't care" conditions to simplify an expression.

Inputs				Output
A	B	C	D	Y
0	0	0	0	X
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



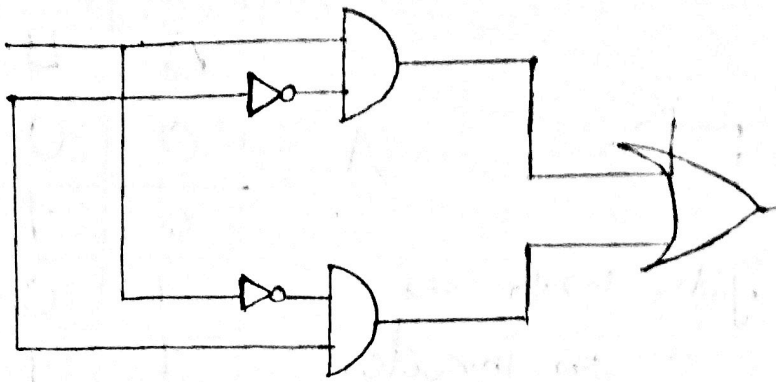
without don't cares:

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

with don't cares:

$Y = A + BCD$

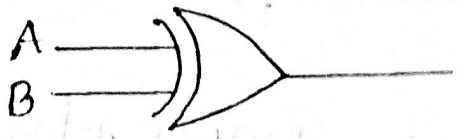
Combinational Logic Circuit:

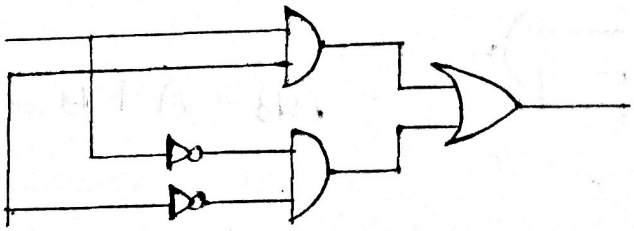


$Y = A\bar{B} + \bar{A}B.$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

$\therefore Y = A \oplus B$

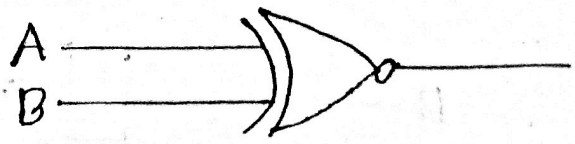




$Y = A\bar{B} + \bar{A}\bar{B}$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

$\therefore Y = \overline{A \oplus B}$



The universal property of NAND and NOR gates.

Truth table for 2 input NAND gate.

A	B	X
0	0	1
0	1	1
1	0	1
1	1	0

(a)

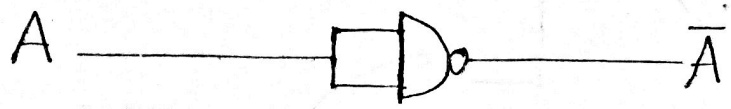


fig: A NAND gate used as an inverter.

(b)

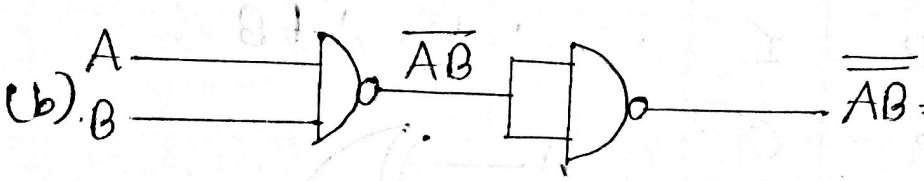


fig: Two NAND gates used as an AND gate.

(c)

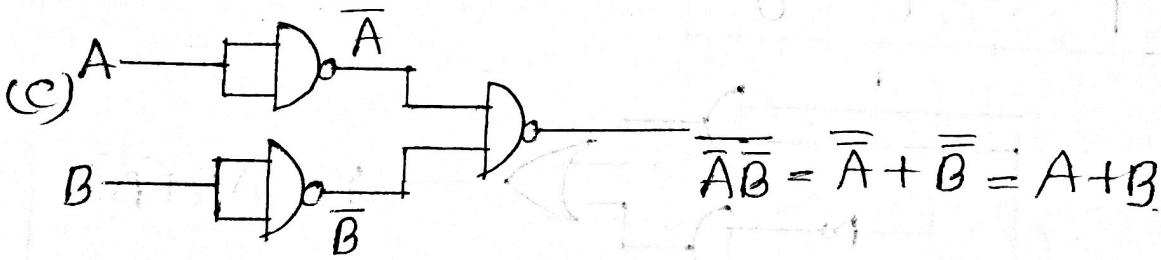


fig: Three NAND gates used as an OR gate.

(d)

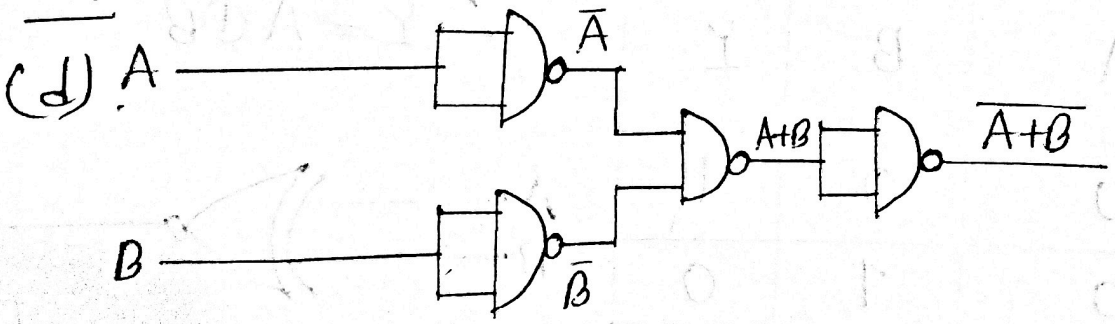


fig: Four NAND gates used as NOR gate.

The NOR Gate as a universal logic element.

Truth table for 2 input NOR Gate.

A	B	X
0	0	1
0	1	0
1	0	0
1	1	0

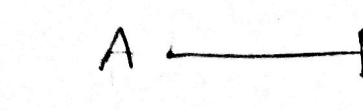


Fig: a NOR gate used as an inverter.

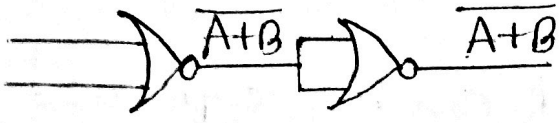


Fig: Two NOR gates used as an OR gate.

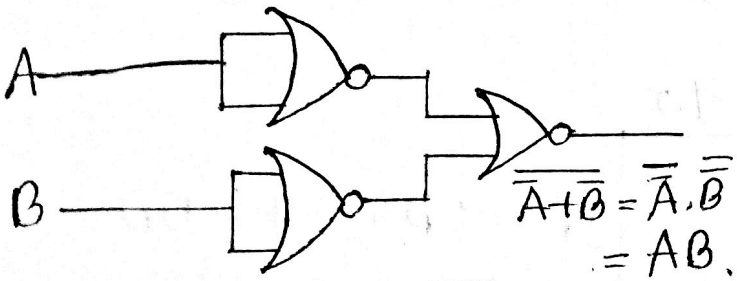


Fig: Three NOR gates used as an AND gate.

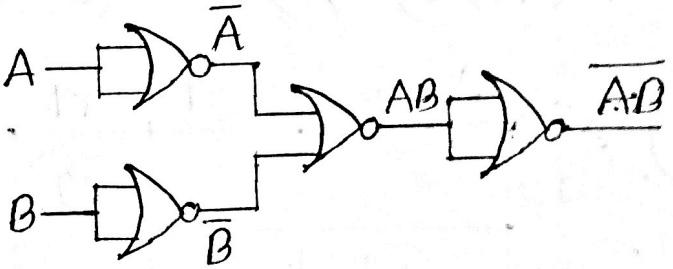


Fig: Four NOR gates used as a NAND gate

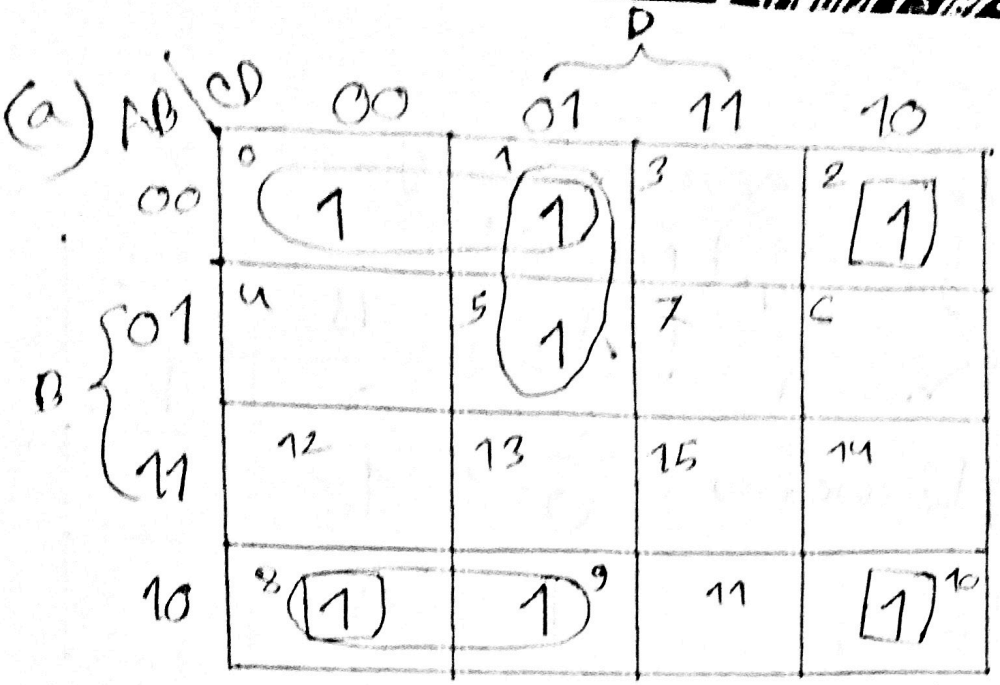
Simplify the Boolean Function in:

(a) Sum of products and

(b) Product of sum form.

$F(A,B,C,D) = \Sigma(0,1,2,5,8,9,10)$

(a)

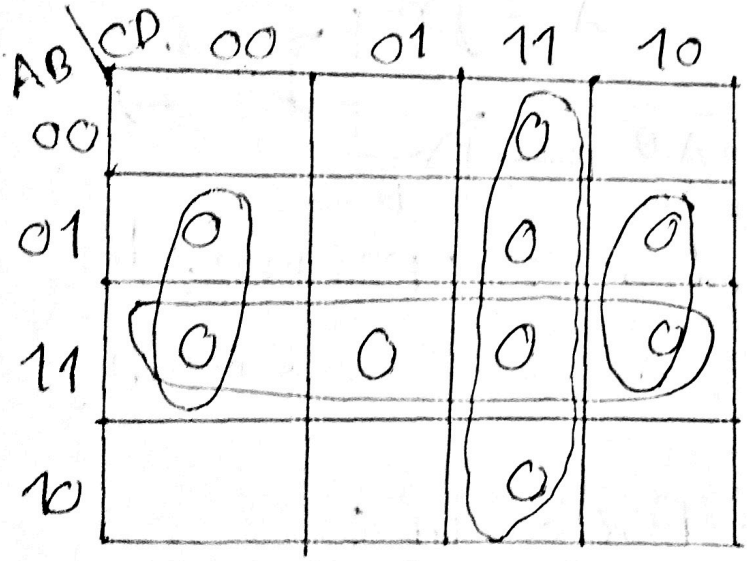


$F = \bar{B}\bar{C} + \bar{B}\bar{D} + \bar{A}\bar{C}\bar{D}$

In product of maxterms, F can be expressed as

$F(A, B, C, D) = \Pi(3, 4, 6, 7, 11, 12, 13, 14, 15)$

(b)



$\bar{F} = CD + AB + B\bar{D}$

$F = \overline{CD + AB + B\bar{D}}$

$= (\overline{CD}).(\overline{AB}).(\overline{B\bar{D}})$

$= (\bar{C} + \bar{D})(\bar{A} + \bar{B})(\bar{B} + D)$

Combinational Logic using NAND and NOR gates:

NAND gate:

using De Morgan's rule:

$$\overline{AB} = \overline{A}+\overline{B}$$

Negative OR.

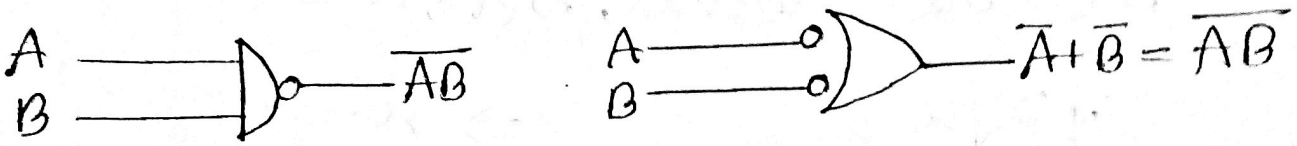
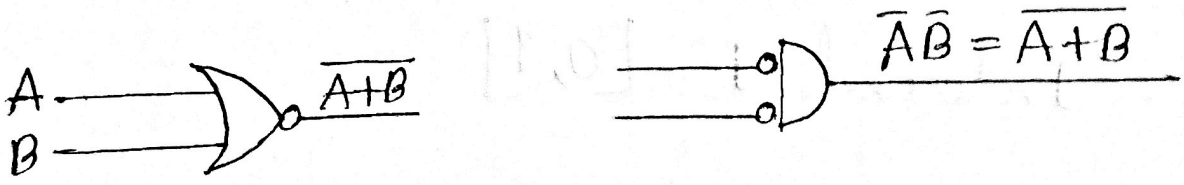


Fig: Two graphic symbols for NAND gate.

$$\overline{A+B} + \overline{A}\,\overline{B}$$

Negative AND.



OR-invert.

Fig: Two graphic symbols for NOR gate.

Exercise 01 :

$$F(w,x,y,z) = \Sigma(1,3,7,11,15)$$

$$d(w,x,y,z) = \Sigma(0,2,5)$$

wx \ yz	00	01	11	10
00	0: X	1: 1	3: 1	2: X
01	4: 0	5: X	7: 1	6: 0
11	12: 0	13: 0	15: 1	14: 0
10	8: 0	9: 0	11: 1	10: 0

y (11, 10) — w (11, 10)

$F = \bar{w}z + yz$ (Combining 1's and X's)

wx \ yz	00	01	11	10
00	0: X	1: 1	3: 1	2: X
01	4: 0	5: X	7: 1	6: 0
11	12: 0	13: 0	15: 1	14: 0
10	8: 0	9: 0	11: 1	10: 0

y (11, 10) — w (11, 10) — z

$\bar{F} = \bar{y}\bar{z} + w\bar{y} + y\bar{z}$

$= \bar{z}(y + y) + w\bar{y}$

$= \bar{z} \cdot 1 + w\bar{y}$ $[\because y + y = 1]$

$= \bar{z} + w\bar{y}$

$\therefore F = \overline{\bar{z} + w\bar{y}}$

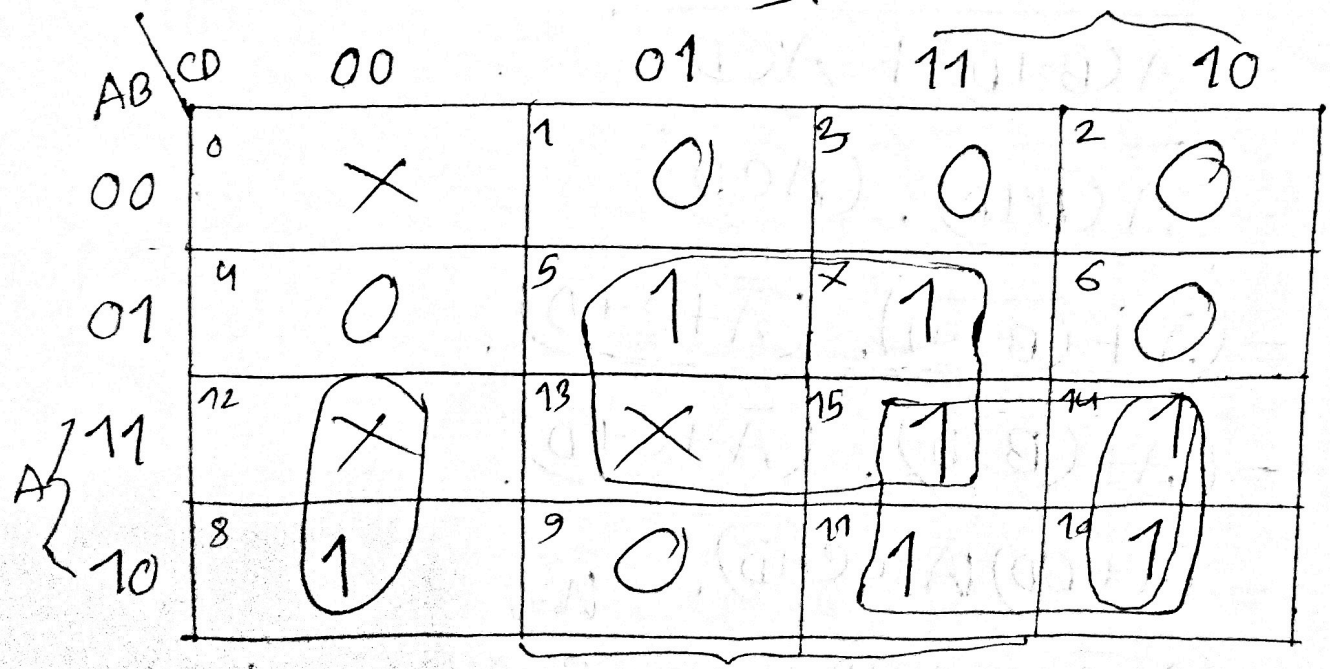
$= \bar{\bar{z}} \cdot (\overline{w\bar{y}})$

$= z(\bar{w} + y)$ (Combining 0's and x's).

Exercise 02 :

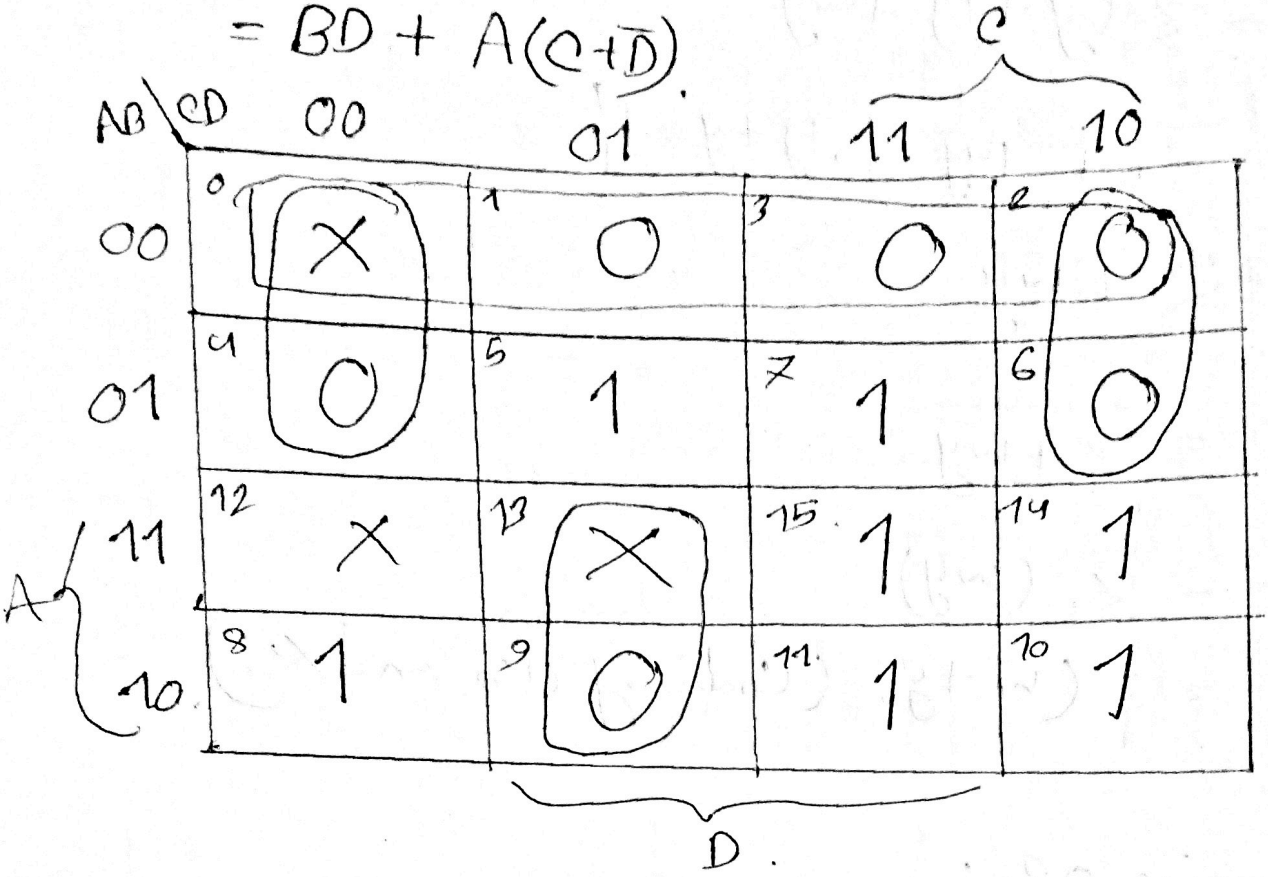
$F(A, B, C, D) = \Sigma(5, 7, 8, 10, 11, 14, 15)$

$d = \Sigma(0, 12, 13)$



$\therefore F = A\bar{D} + BD + AC$

$= BD + A(C+\bar{D})$.



$\bar{F} = \bar{A}\bar{D} + \bar{A}\bar{B} + A\bar{C}D.$

$= \bar{A}(\bar{B}+\bar{D}) + A\bar{C}D.$

$\therefore F = \overline{\bar{A}(\bar{B}+\bar{D}) + A\bar{C}D}$

$= \overline{\bar{A}(\bar{B}+\bar{D})} \cdot \overline{(A\bar{C}D)}$

$= \left(\bar{\bar{A}} + \overline{(\bar{B}+\bar{D})}\right) \cdot (\bar{A}+\bar{\bar{C}}+\bar{D})$

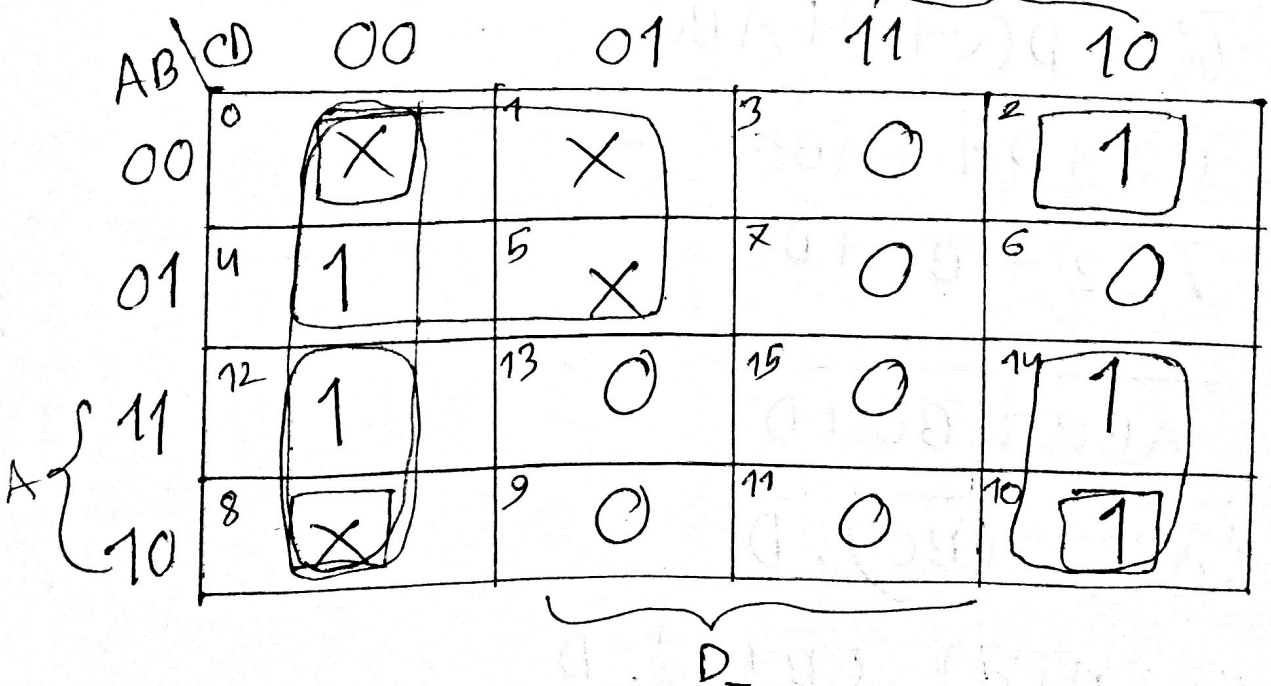
$= (A + (\bar{\bar{B}} \cdot \bar{\bar{D}})) \cdot (\bar{A}+C+\bar{D})$

$= (A+BD)(\bar{A}+C+\bar{D})$. (Ans).

Exercise 03 :

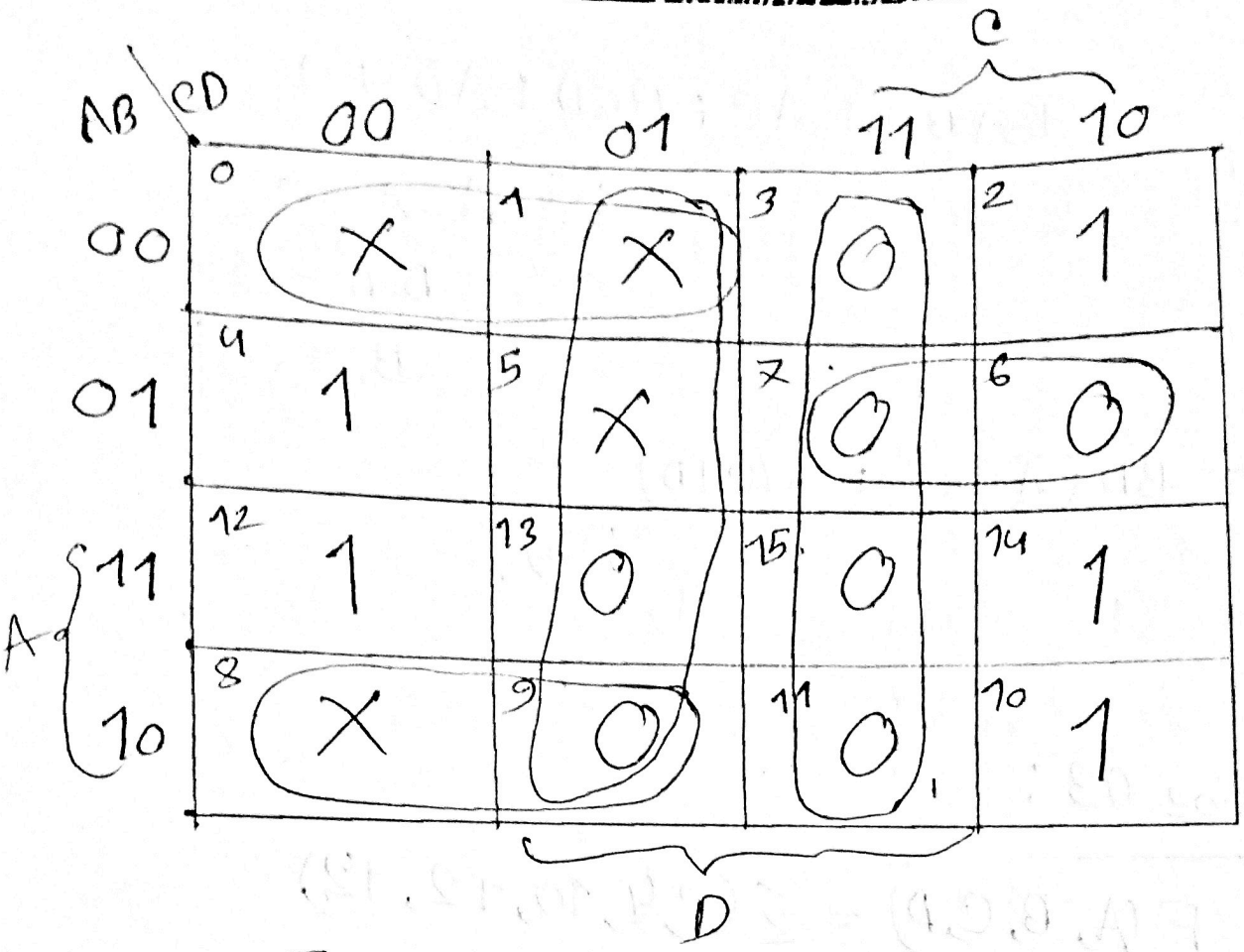
$$F(A,B,C,D) = \Sigma(2,4,10,12,14)$$

$$d(A,B,C,D) = \Sigma(0,1,5,8)$$



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

$$= \bar{C}(\bar{A}+\bar{D}) + \bar{D}(A+\bar{B})$$



$$\bar{F} = \bar{B}\bar{C} + \bar{C}D + CD + \bar{A}BC$$

$$= \bar{B}\bar{C} + D(\bar{C}+C) + \bar{A}BC$$

$$= \bar{B}\bar{C} + D.1 + \bar{A}BC.$$

$$= \bar{A}BC + \bar{B}\bar{C} + D.$$

$$F = \overline{\bar{A}BC + \bar{B}\bar{C} + D.}$$

$$= \overline{(\bar{A}BC)}.\ \overline{(\bar{B}\bar{C})}.\ \bar{D}$$

$$= (\bar{\bar{A}} + \bar{B} + \bar{C}).\ (\bar{\bar{B}} + \bar{\bar{C}}).\ \bar{D}$$

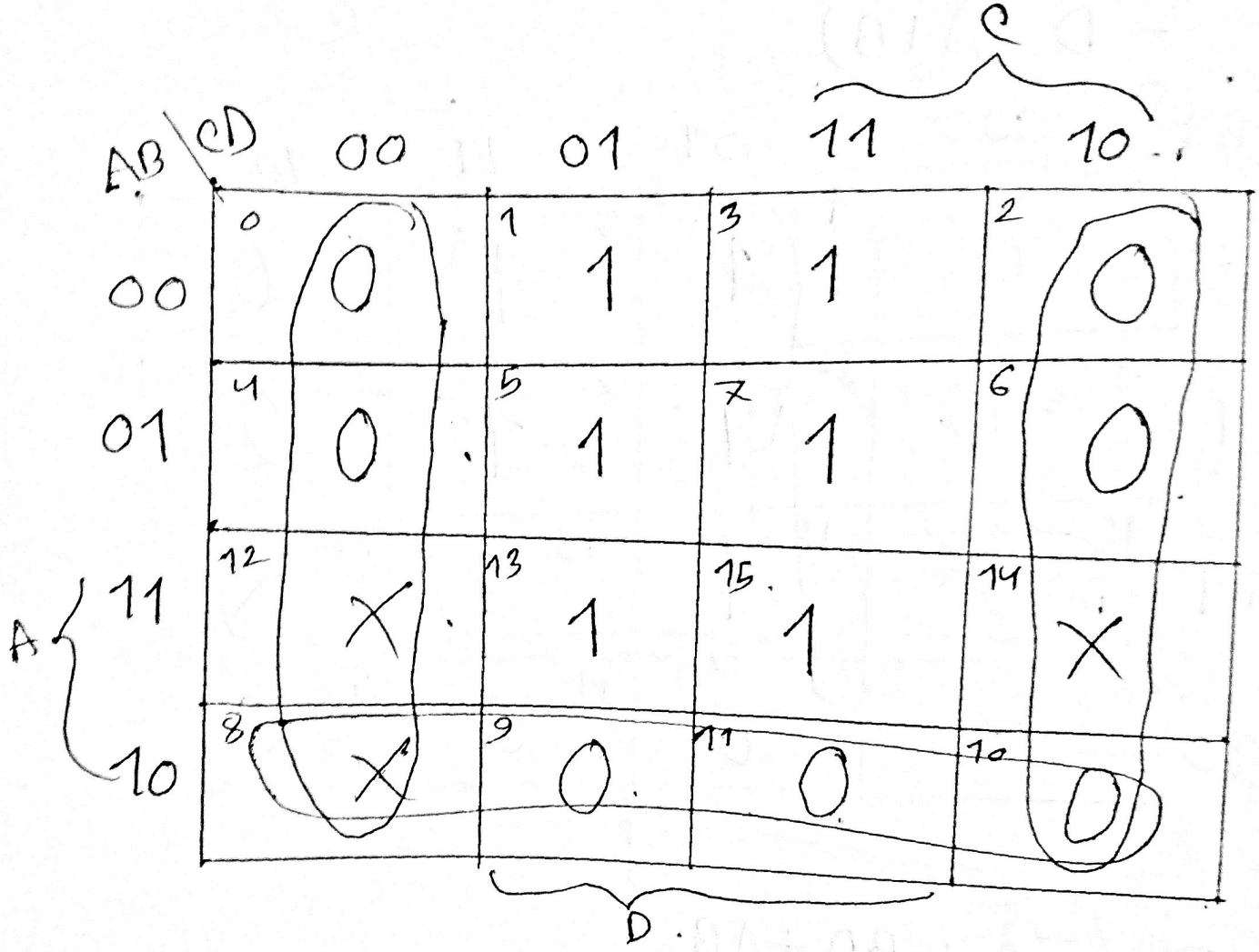
$$= (A + \bar{B} + \bar{C}).\ (B + C).\ \bar{D}$$

Ans).

Exercise 04 :

$F(A, B, C, D) = \Pi(1, 3, 5, 7, 13, 15)$.

$d(A, B, C, D) = \Pi(8, 12, 14)$.



$\overline{F} = \overline{C}\,\overline{D} + C\overline{D} + A\overline{B}$.

$= \overline{D}(\overline{C} + C) + A\overline{B}$

$= \overline{D} \cdot 1 + A\overline{B}$ $[\because \overline{C} + C = 1]$

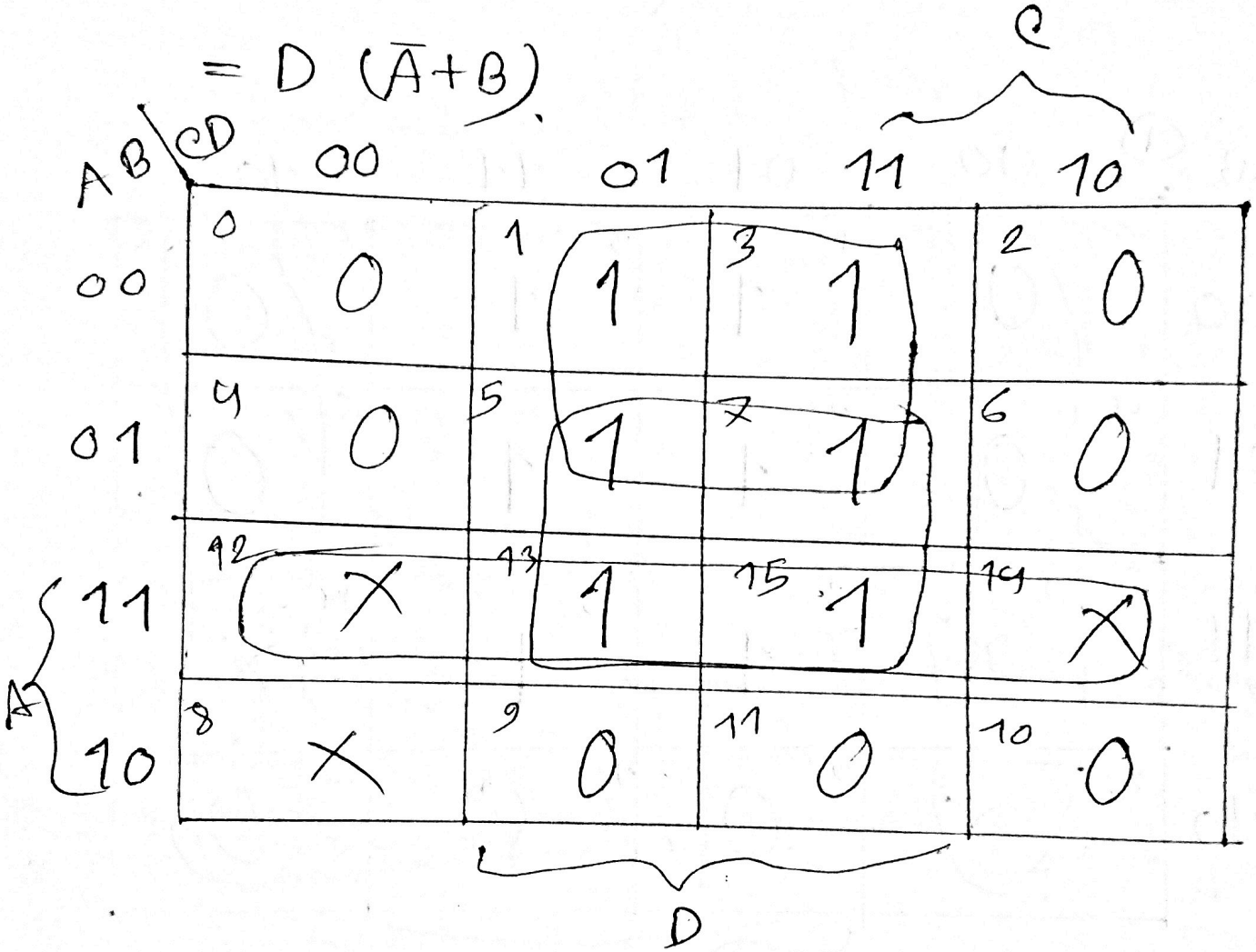
$= \overline{D} + A\overline{B}$.

$\therefore F = \overline{\bar{D} + A\bar{B}}$

$= \bar{\bar{D}} \cdot (\overline{A\bar{B}})$

$= \bar{D} \cdot (\bar{A} + \bar{\bar{B}})$

$= D(\bar{A} + B)$



$F = \bar{A}D + BD + AB$

$= AB + D(\bar{A} + B)$

(Ans)

Exercise 05:

$$F(A,B,C,D) = \Pi\,(1,3,6,9,11,12,14)$$
$$d(A,B,C,D) = \Pi\,(2,4,10,13,15)$$

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

A (11, 10) — C (11, 10) — D (01, 11)

$$\bar{F} = B\bar{D} + \bar{B}\bar{D} \quad \therefore F = \overline{B\bar{D} + \bar{B}\bar{D}} = (\bar{B}+\bar{D})(B+D)$$

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

A (11, 10) — C (00, 10) — D (01, 11)

$$F = B\bar{D} + \bar{B}D + C\bar{D} + AB = AB + \bar{B}D + \bar{D}(B+C)$$ Ans