AKTU B.Tech II-Year

GATEWAY CLASSES

EC & EC Allied

DSD : Digital System Design

Unit-1 Lec-5

Gateway Classes



Avinash Sir

Today's target

- Karnaugh maps up to 5 variables
- PYQ
- DPP

AKTU : *DIGITAL SYSTEM DESIGN (BEC-302)* Syllabus

UNIT-1 : Logic simplification and combinational logic design

- Number Systems
- Binary arithmetic
- Signed magnitude representation
- Binary codes, code conversion
- Review of Boolean algebra and Demorgans theorem
- SOP & POS forms
- Canonical forms
- Karnaugh maps up to 5 variables
- Tabulation method.

Gateway Classes

Karnaugh Map (K-map)

- The K-map is a pictorial representation of truth table of the Boolean function and used to minimize the Boolean function
- K-map matrix contain 2^n cell, where n is the total number of variables

K-map

For SOP form

Each Cell contain a Minterm

0	Variable with complement $\bar{A}$
1	Variable without complement A

For POS form

Each cell contain a Maxterm

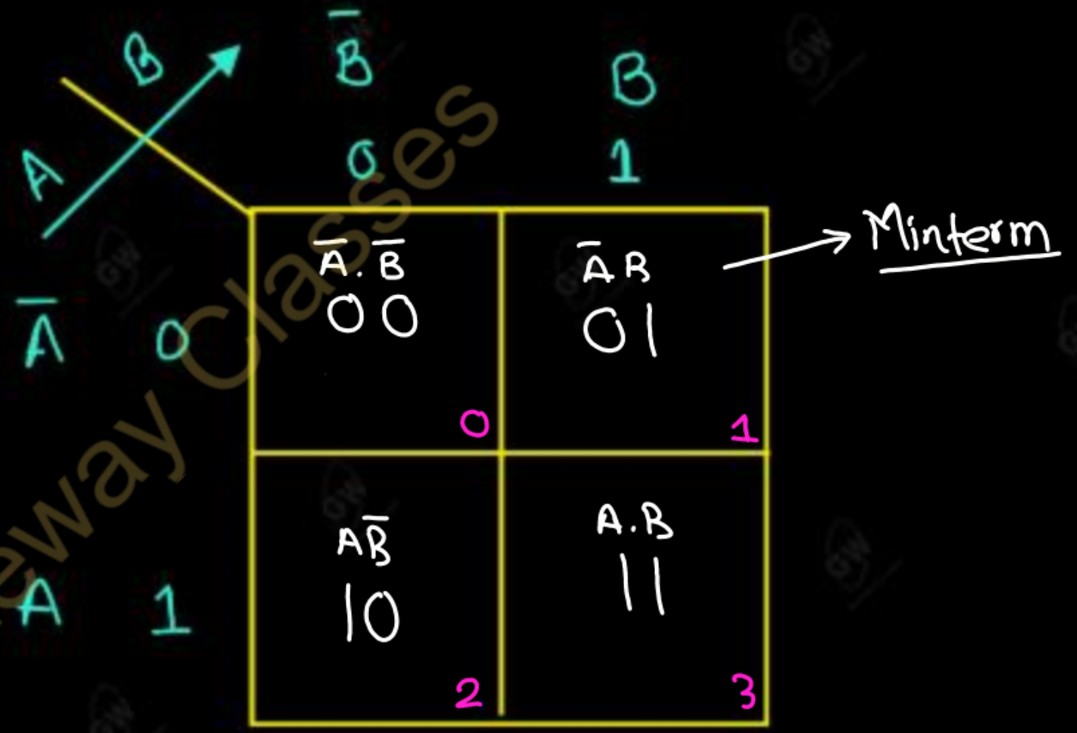
A	0 Variable without complement
$\bar{A}$	1 Variable with complement

Gateway Classes

K-Map for SOP Form

(1) For two variable A and B

- No of cells in K-map = $2^2 = 4$
- Each cell contain a Minterm



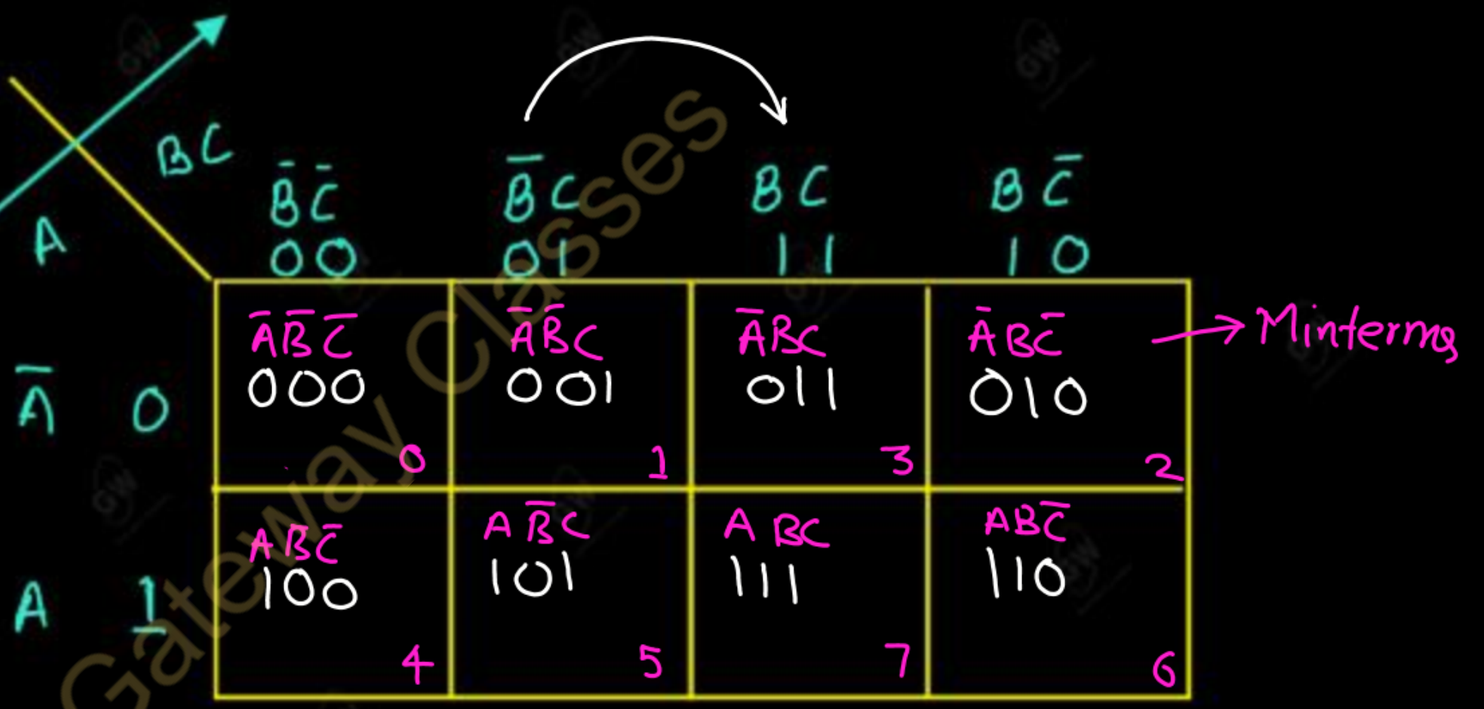
Gateway Classes

(2) For three variables A , B , C

- No of cells in K-map = $2^3 = 8$
- Each cell contain a Minterm

2nd last → Last
Last → 2nd Last

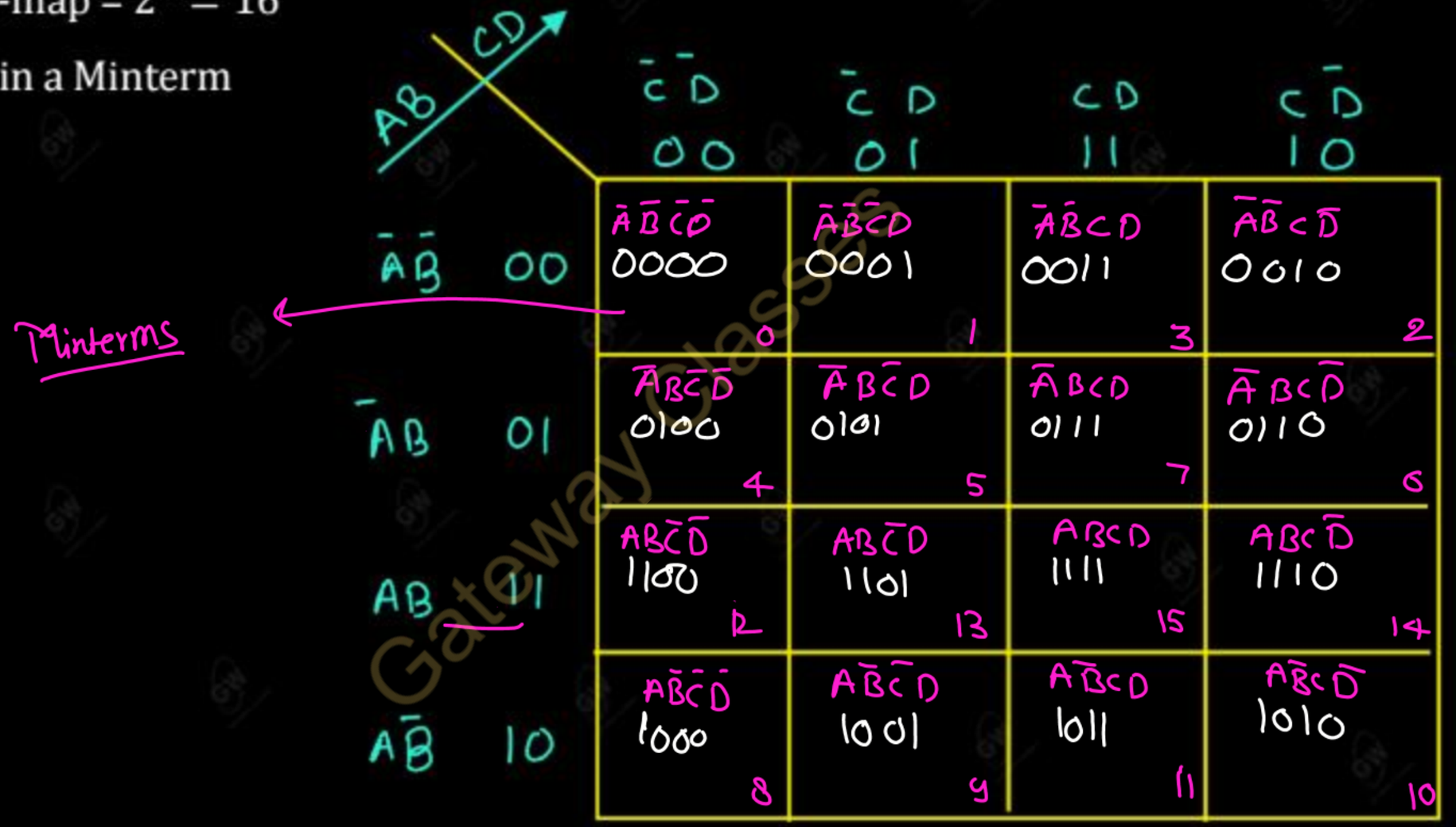
Gray code



Gateway Classes

(3) For four variables A , B , C , D

- No of cells in K-map = $2^4 = 16$
- Each cell contain a Minterm



Gateway Classes

Rule of Minimization

- Put 1 for each Minterm and 0 for each maxterm
- Formation of Groups : Form minimum number of groups and Form big size group

(1) 16 Group = 2^4 (4 Variables minimise)

(2) 8 Group = 2^3 (3 Variables minimise) octacte

(3) 4 Group = 2^2 (2 Variables minimise) Quad

(4) 1 Group = 2^0 (0 Variables minimise)

(5) 2 Group = 21 (1 " ") Pair

GatewayClasses

Q.1 Simplify the following function using K-map F (A, B) = Σ m(0, 1, 3)

$F(A,B) = \Sigma m(0,1,3)$

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

Minterms

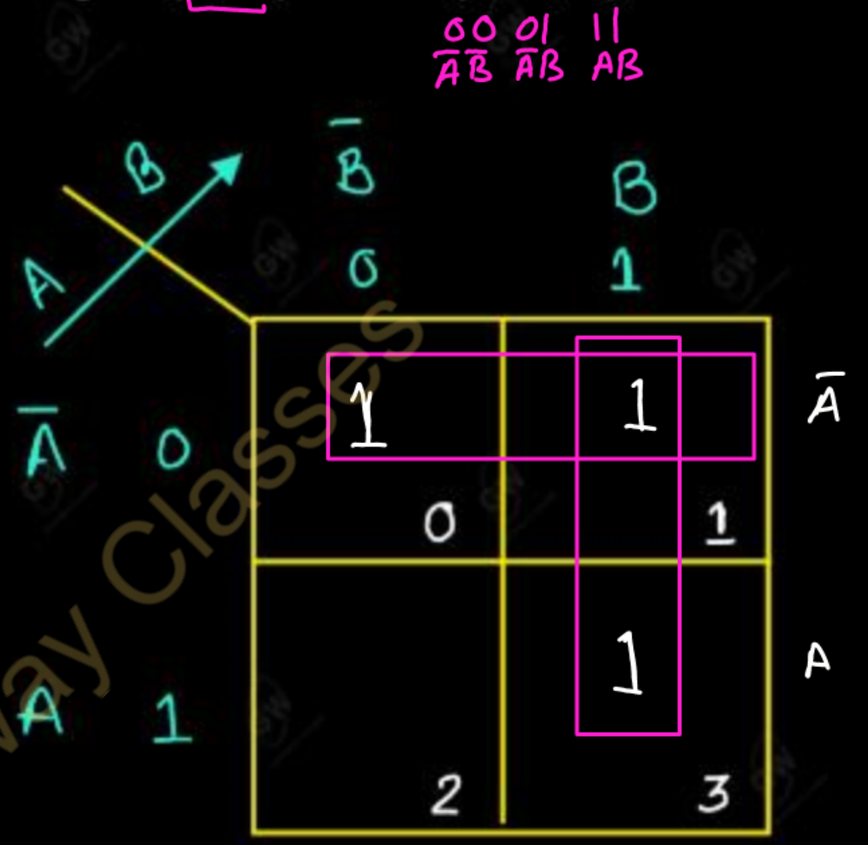
$\bar{A}(\bar{B}+B) + AB$

$\bar{A} + AB$

$(\bar{A}+A).(\bar{A}+B)$

$1.(\bar{A}+B)$

$F = \bar{A} + B$



Gateway Classes

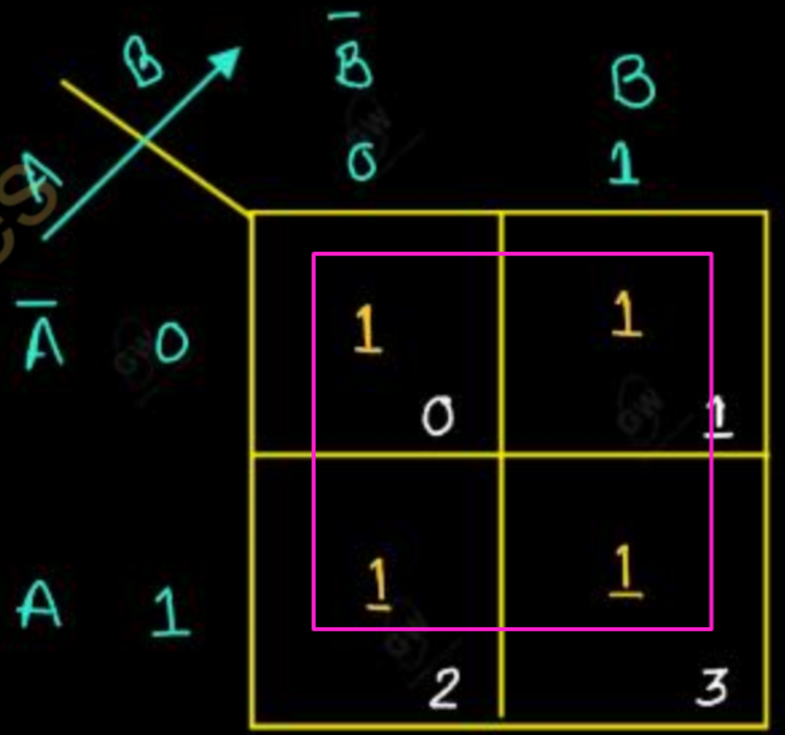
Q.2 Simplify the following function using K-map $F(A, B) = \Sigma m(0, 1, 2, 3)$

$\bar{A}\bar{B} + \bar{A}B + A\bar{B} + AB$
00 01 10 11

$F(A,B) = 1$

Diagonal ×

Ver. ✓
Hori. ✓



Gateway Classes

Q.3 Simplify the following function using K-map $F(A, B, C) = \Sigma m(0, 1, 3, 6, 7)$

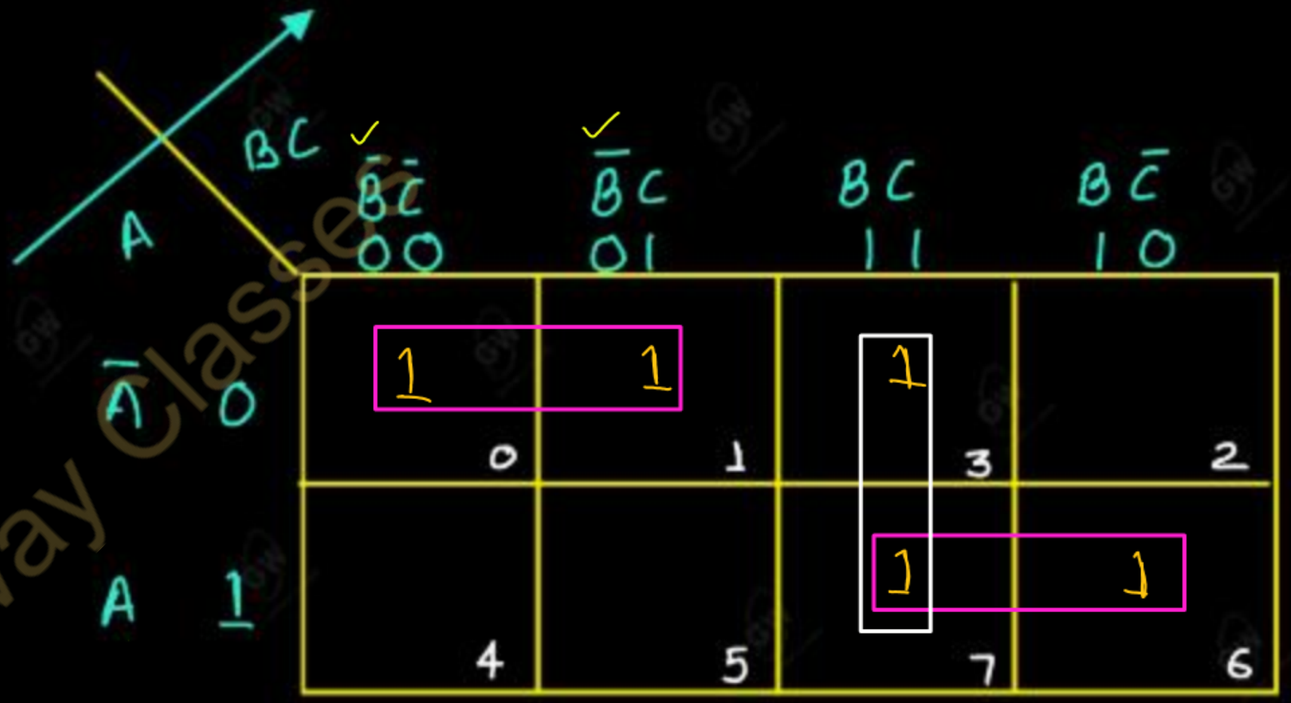
000 001 011 110 111

$\bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C + \bar{A}BC + AB\bar{C} + ABC$

$F(A,B,C) = \bar{A}\bar{B} + AB + BC$

$\therefore$

No of Groups = No of minterms



Gateway Classes

Q.4 Simplify the logic function using K-map

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$$Y = \sum m\,(0, 2, 3, 4, 6, 7, 9, 11, 16, 18, 19, 20, 22, 23, 25, 27)$$

(A, B, C, D, E)

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

$A = 0$, $\bar{A}$

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	1 (0)	(1)	1 (3)	1 (2)
$B\bar{C}$ 01	1 (4)	(5)	1 (7)	1 (6)
BC 11	(12)	(13)	(15)	(14)
$B\bar{C}$ 10	(8)	1 (9)	1 (11)	(10)

$A = 1$, A

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
BC 00	1 (16)	(17)	1 (19)	1 (18)
BC 01	1 (20)	(21)	1 (23)	1 (22)
BC 11	(28)	(29)	(31)	(30)
BC 10	(24)	1 (25)	1 (27)	(26)

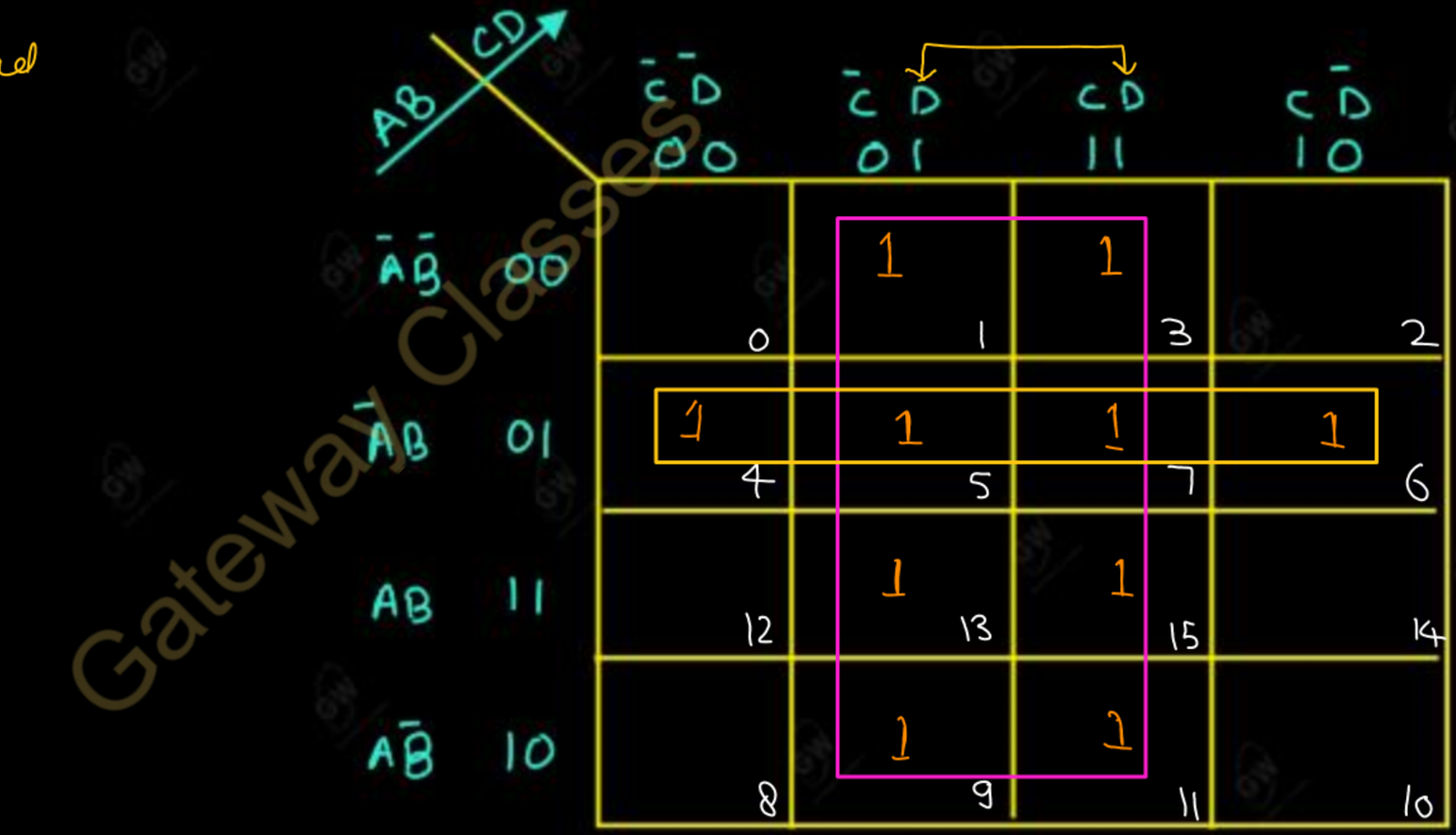
Gateway Classes

Q.5 Simplify the following function using K-map F (A, B, C, D) = Σ (1, 3, 4, 5, 6, 7, 9, 11, 13, 15).
Also implement the simplified function using basic gates only.

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

D → Octat

$\bar{A}B$ → Quad



Gateway Classes

Q.6 Simplify the following function using K-map

AKTU-2024- 25

$$F(A, B, C, D) = \Sigma(8, 9, 10, 11, 13, 15, 16, 18, 21, 24, 25, 26, 27, 30, 31).$$

$$F = B\bar{C} + \bar{A}BE + ABD + A\bar{B}C\bar{E} + A\bar{B}CD\bar{E}$$

E

$A = 0$ $\bar{A}$

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	0	1	3	2
$B\bar{C}$ 01	4	5	7	6
BC 11	12	13	15	14
$B\bar{C}$ 10	8	9	11	10

$A = 1$ A

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	16	17	19	18
$B\bar{C}$ 01	20	21	23	22
BC 11	28	29	31	30
$B\bar{C}$ 10	24	25	27	26

Gateway Classes

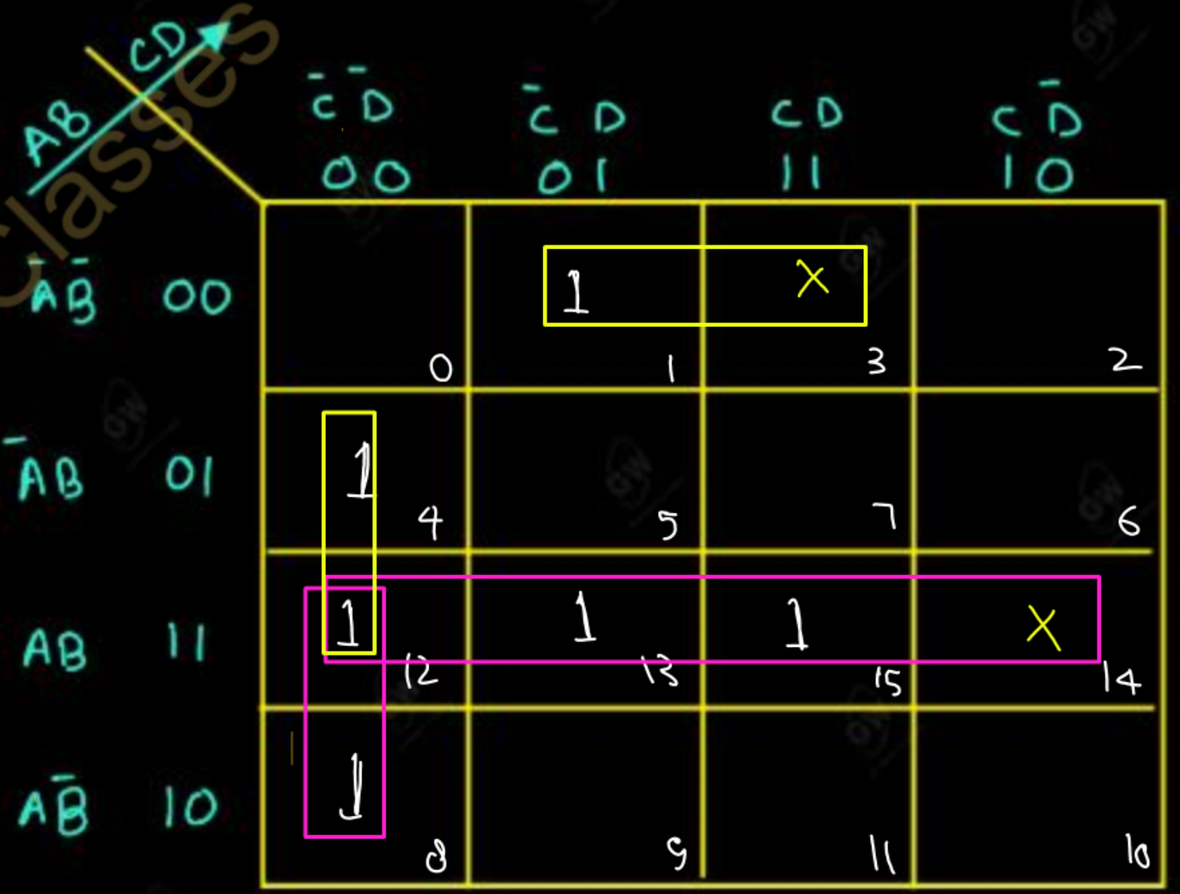
Don't Care Condition

Combination of inputs on which the output may or may not depends are called Don't Care Condition

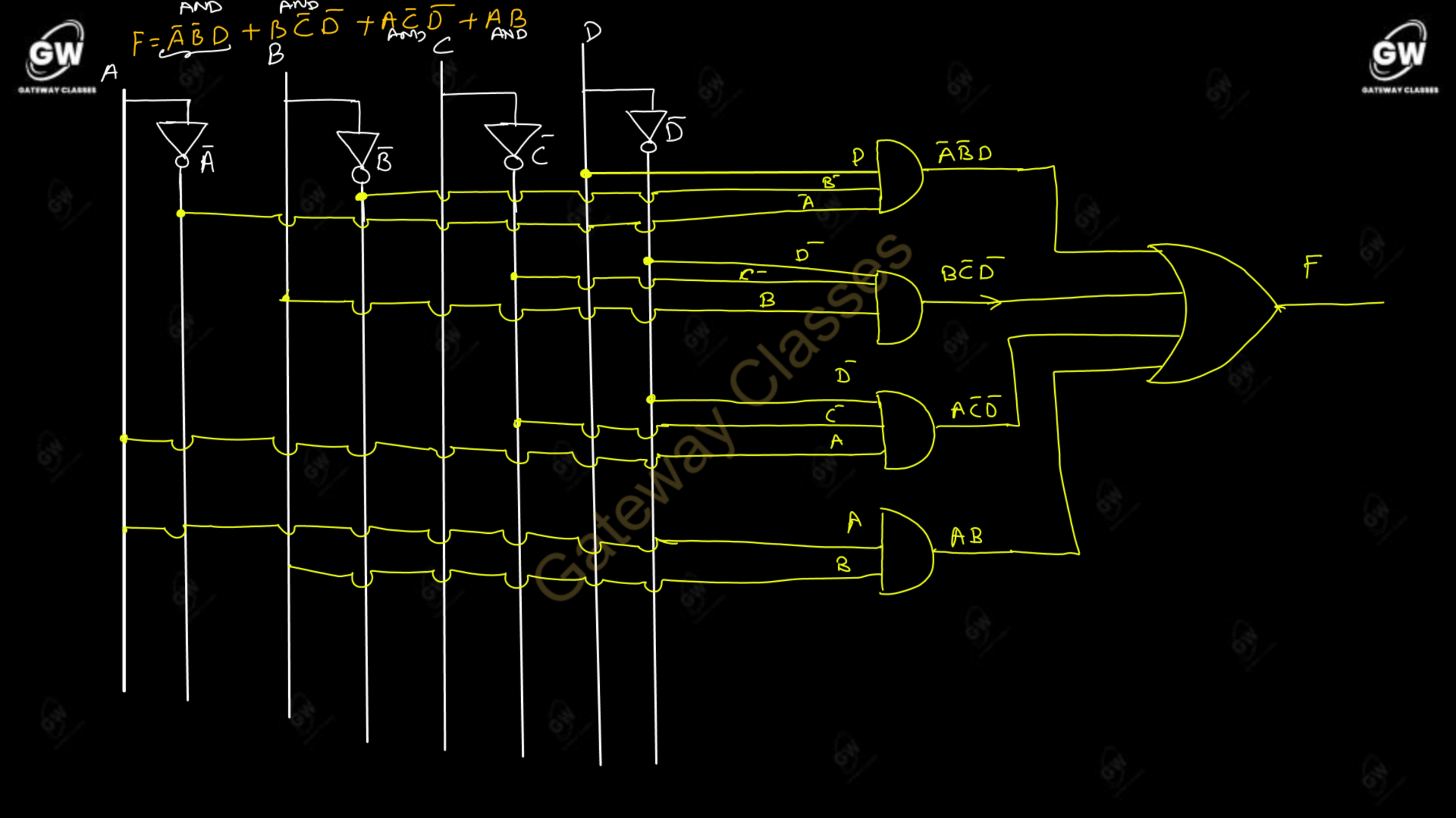
Q.7 Minimize using K-map and realize output using gates.

$$F(A, B, C, D) = \Sigma m(1, 4, 8, 12, 13, 15) + d(3, 14)$$

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



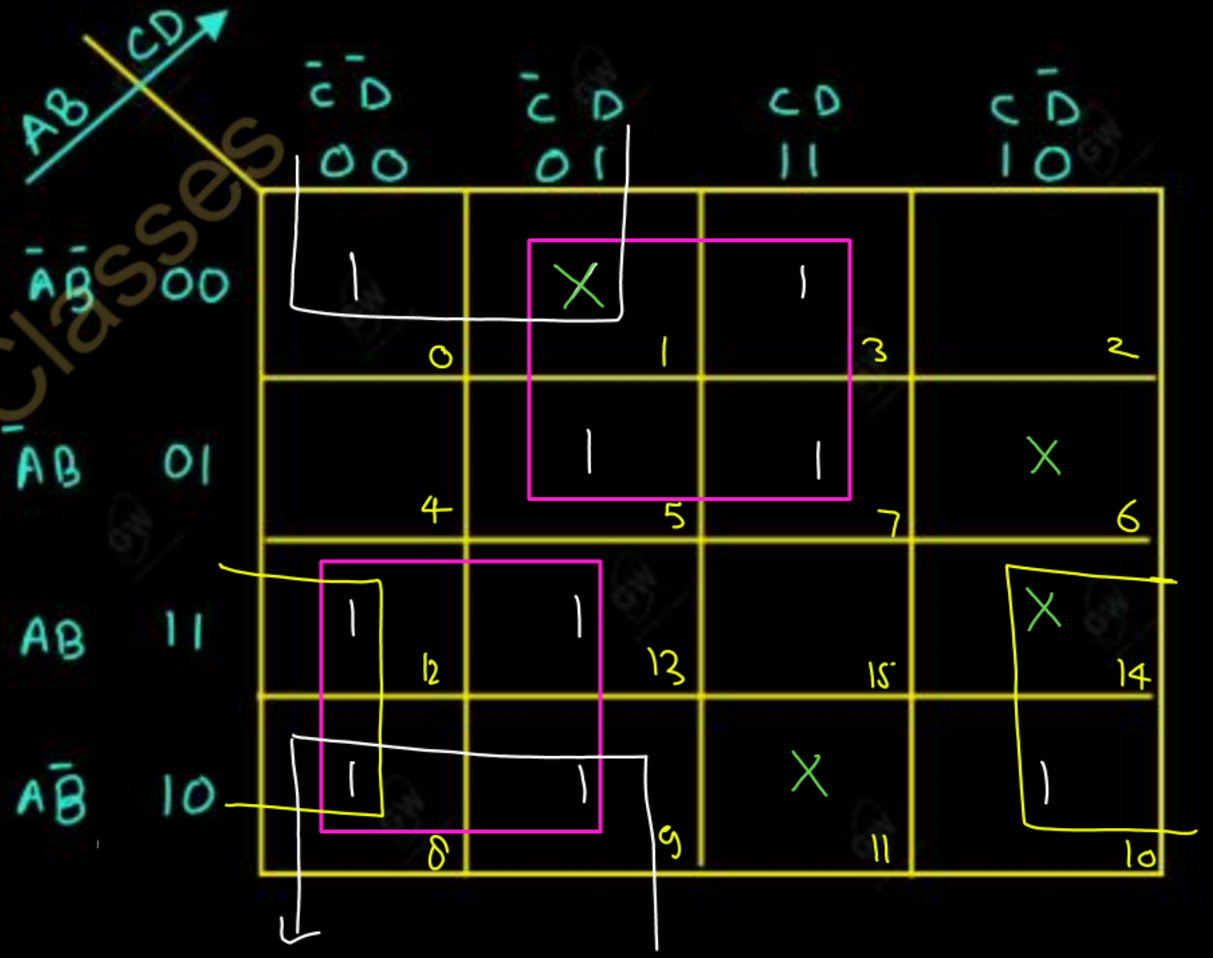
Gateway Classes



GW
GATEWAY CLASSES
Gateway Classes

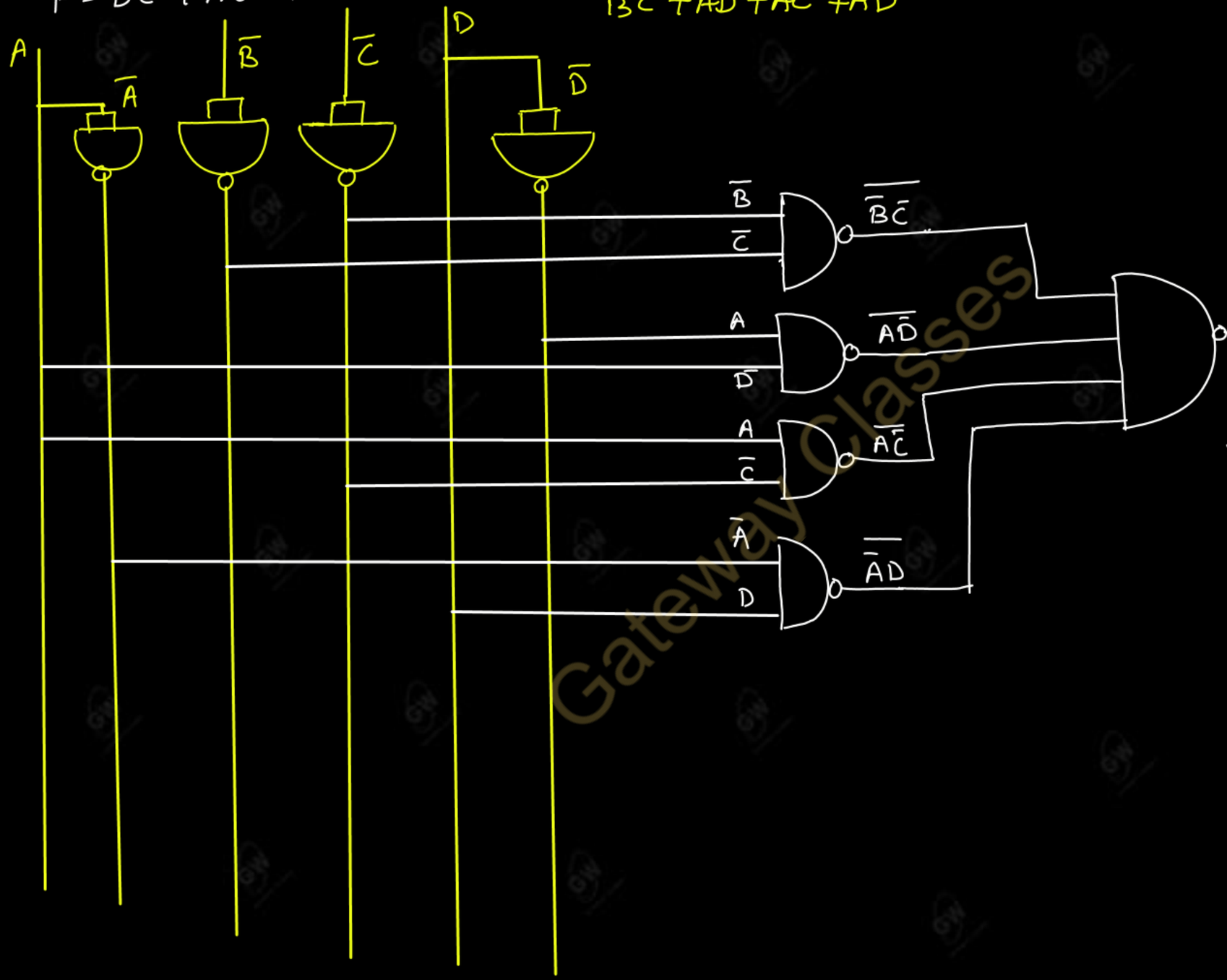
Q.8 Simplify the function $F = \Sigma m\,(0,3,5,7,8,9,10,12,13) + \Sigma d\,(1,6,11,14)$ using K-map and implement the simplified expression using NAND gates only

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



Gateway Classes

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



$\overline{\overline{\bar{B}\bar{C}} \cdot \overline{A\bar{D}} \cdot \overline{A\bar{C}}\ \overline{\bar{A}D}}$

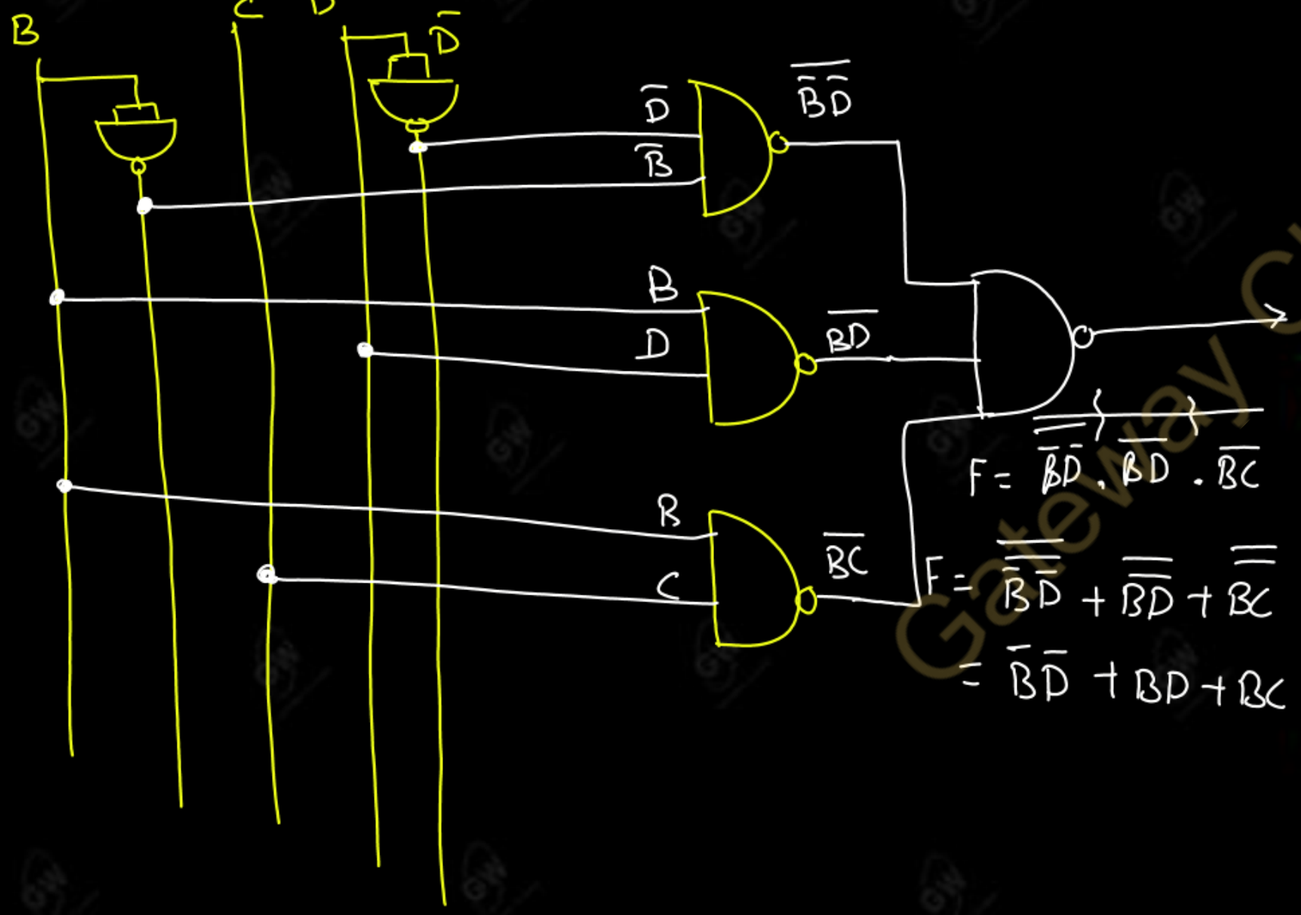
$F = \overline{\overline{\bar{B}\bar{C}}} + \overline{\overline{A\bar{D}}} + \overline{\overline{A\bar{C}}} + \overline{\overline{\bar{A}D}}$

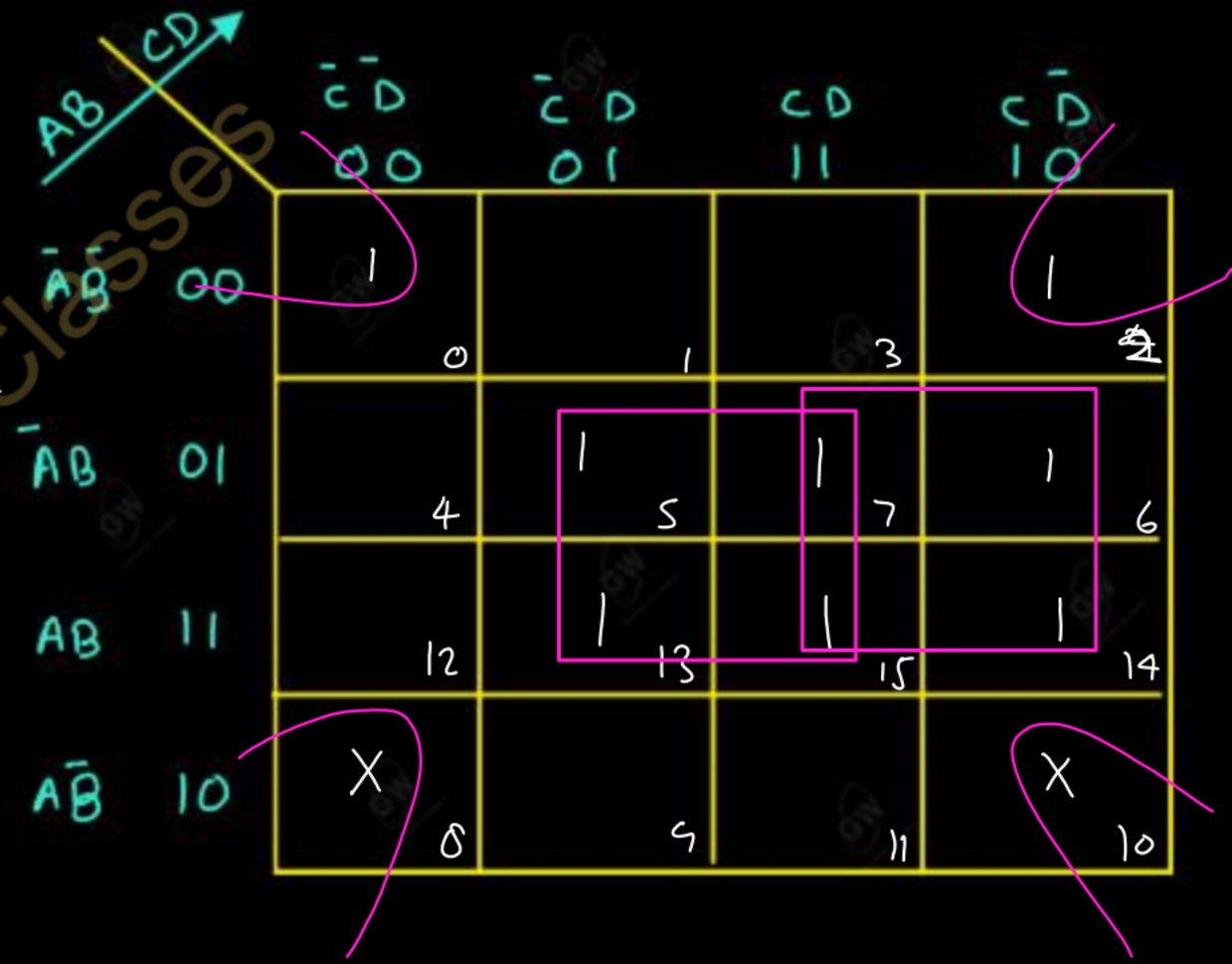
$F = \bar{B}\bar{C} + A\bar{D} + A\bar{C} + \bar{A}D$

Gateway Classes

Q.9 Simplify the function F (A, B, C, D) = Σ m(0, 2, 5, 6, 7, 13, 14, 15) + d (8, 10) using K-map and implement the simplified function using NAND gates only.

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





Gateway Classes

Q.10 - F (A, B, C, D, E) = Σm (0,1,2,4,5,6,10,13,14,18,21,22,24,26,29,30). Simplify the function with help of K-map and realize the simplified function using basic logic gates.

Do Yourself

A = 0

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00				
$B\bar{C}$ 01				
BC 11				
$B\bar{C}$ 10				

A = 1

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
BC 00				
BC 01				
BC 11				
BC 10				

Gateway Classes

Q.11 Simplify the following Boolean expression using K-map.

$$f(V, W, X, Y, Z) = \sum m(0,7,8,9,12,13,15,16,22,23,30,31)$$

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

$\bar{A}$, $A = 0$

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	1 (0)	(1)	(3)	(2)
$B\bar{C}$ 01	(4)	(5)	1 (7)	(6)
BC 11	1 (12)	1 (13)	1 (15)	(14)
$B\bar{C}$ 10	1 (8)	1 (9)	(11)	(10)

$A = 1$

BC \ DE	$\bar{D}\bar{E}$ 00	$\bar{D}E$ 01	DE 11	$D\bar{E}$ 10
$\bar{B}\bar{C}$ 00	1 (16)	(17)	(19)	(18)
$\bar{B}C$ 01	(20)	(21)	1 (23)	1 (22)
BC 11	(28)	(29)	1 (31)	1 (30)
$B\bar{C}$ 10	(24)	(25)	(27)	(26)

Gateway Classes

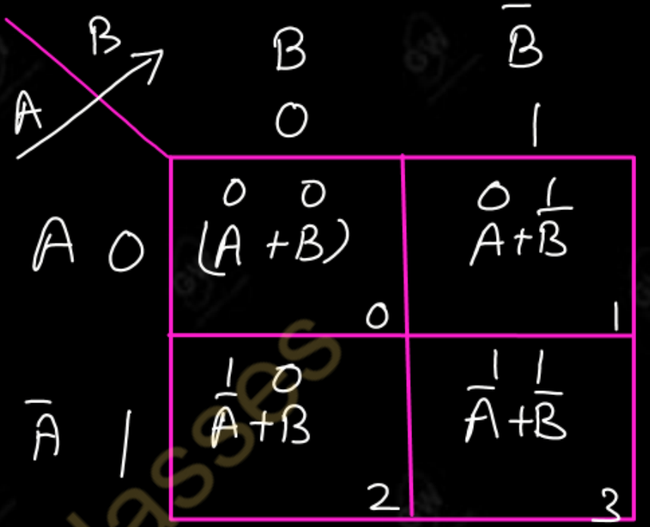
K-Map for POS Form

(1) For two variable A and B

- No of cells in K-map = $2^2 = 4$
- Each cell contain a Maxterm

0 ⟶ Un complemented

1 → Complemented.



Gateway Classes

(2) For three variables A , B , C

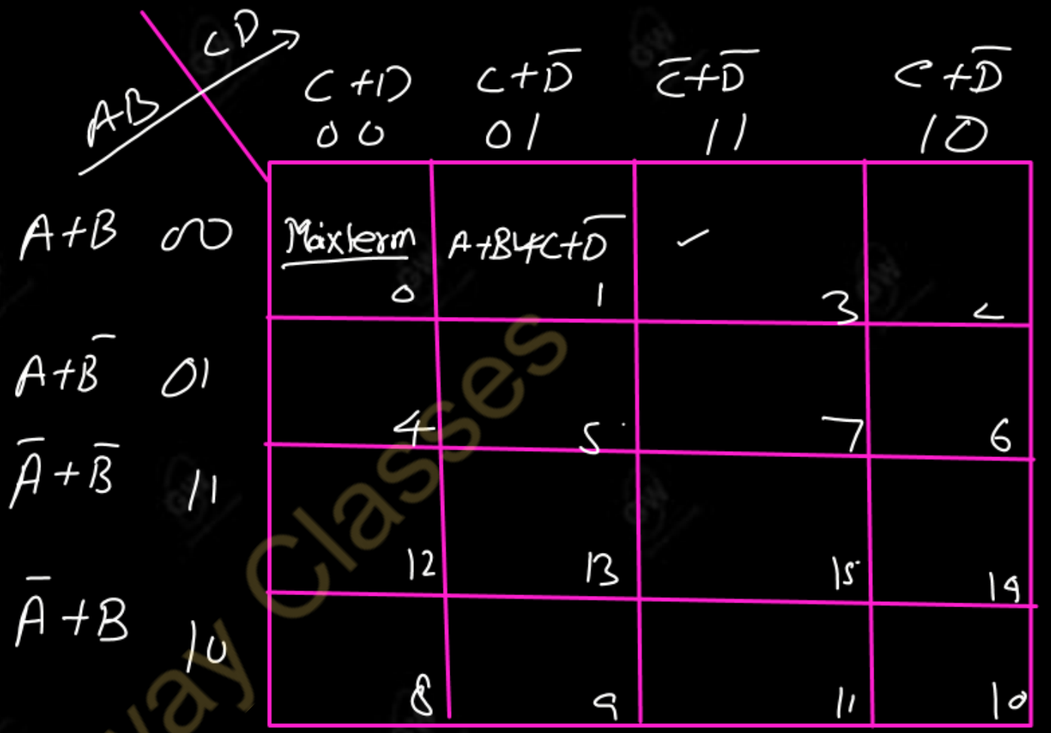
- No of cells in K-map = $2^3 = 8$
- Each cell contain a Maxterm

A \ BC	$B+C$ (00)	$B+\bar{C}$ (01)	$\bar{B}+\bar{C}$ (11)	$\bar{B}+C$ (10)
A (0)	$A+B+C$ 0	$A+B+\bar{C}$ 1	$A+\bar{B}+\bar{C}$ 3	$A+\bar{B}+C$ 2
$\bar{A}$ (1)	$\bar{A}+B+C$ 4	$\bar{A}+B+\bar{C}$ 5	$\bar{A}+\bar{B}+\bar{C}$ 7	$\bar{A}+\bar{B}+C$ 6

Gateway Classes

(3) For three variables A , B , C , D

- No of cells in K-map = $2^4 = 16$
- Each cell contain a Maxterm



Gateway Classes

ΣM

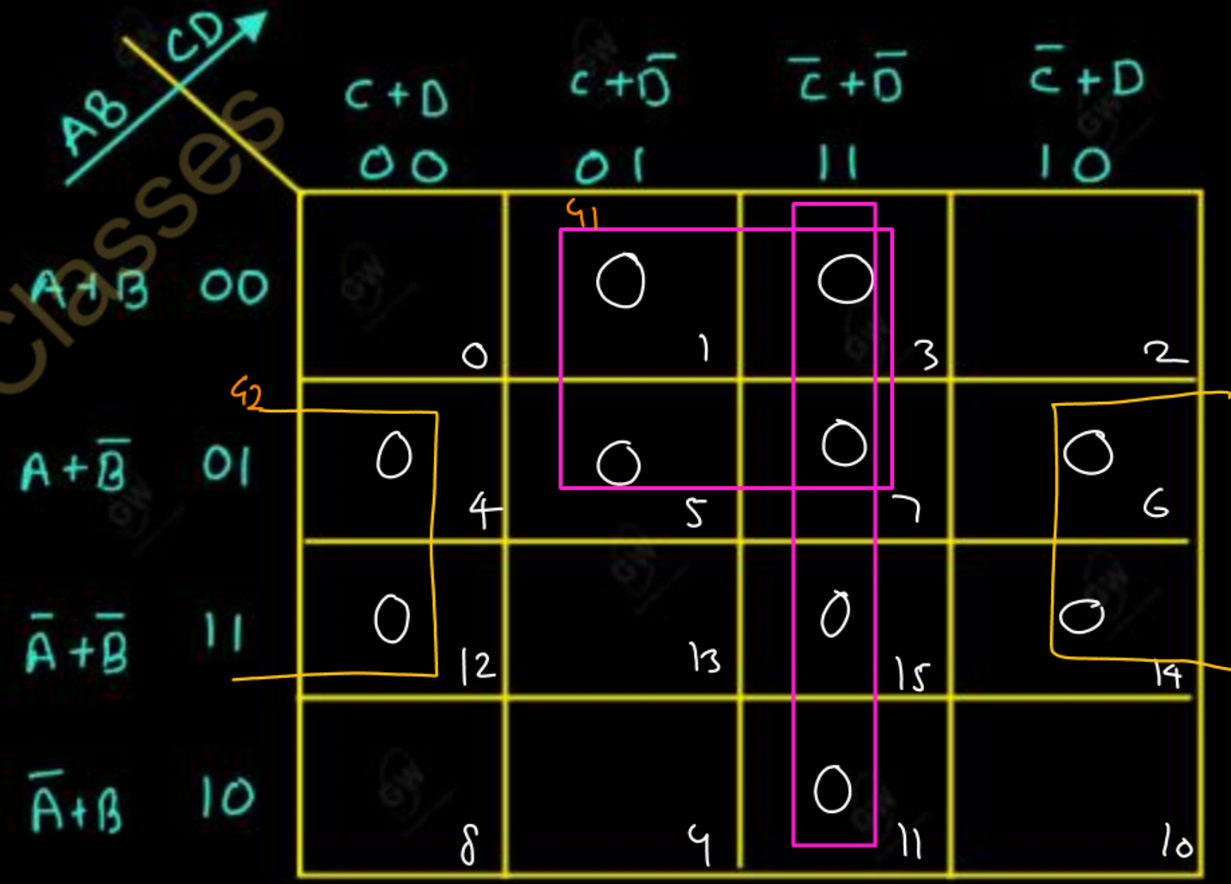
GWQ.1 Simplify the Boolean expression using K-map and implement the simplified expression using NOR GATEs only F (A, B, C,D)=Π M(1,3,4,5,6,7,11,12,14,15)

0001 → 0011

0001 (A+B+C+D̄)

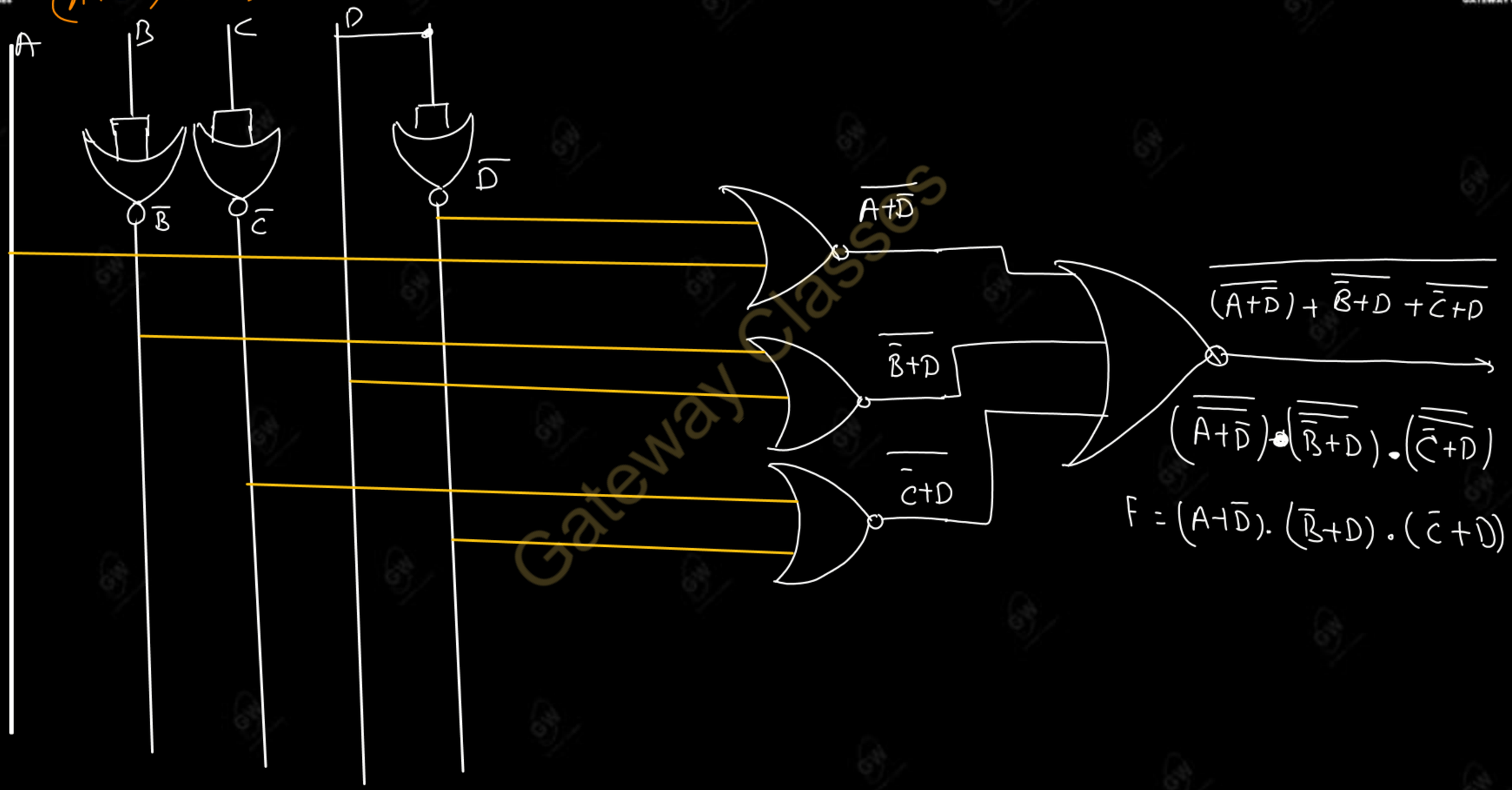
(A+B+C+D̄)

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



Gateway Classes

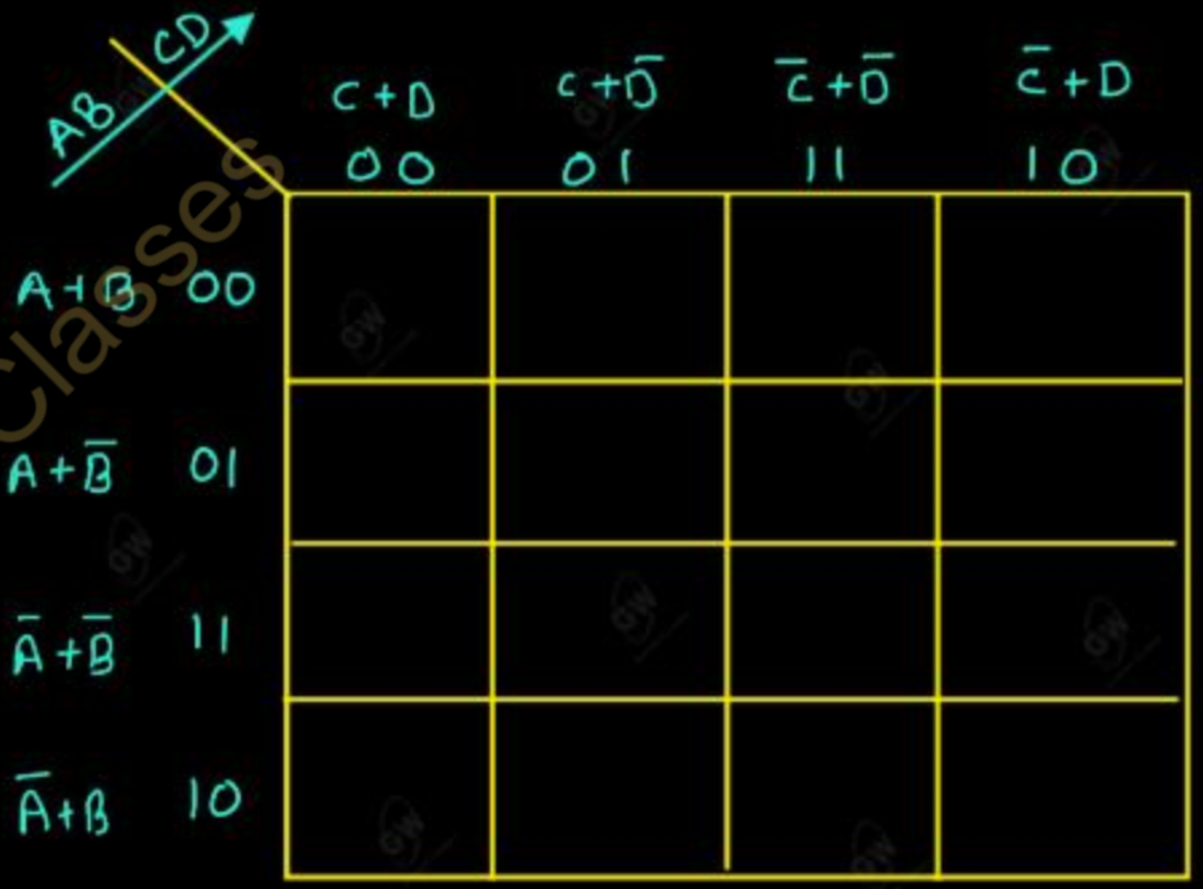
$(A+\bar{D})(\bar{B}+D)(\bar{C}+\bar{D})$



Gateway Classes

Q.2 Simplify the function F= ΠM (0, 2, 10, 11, 12, 14, 15)• Π d (5,13)using K-map and implement the simplified expression using NOR gates only.

Try yourself



Gateway Classes

Q.3 Minimize using K-map and realize using NOR gates only

$$F(A, B, C, D) = \Pi M(3, 4, 5, 7, 9, 13, 14, 15).\ d(0, 2, 8).$$

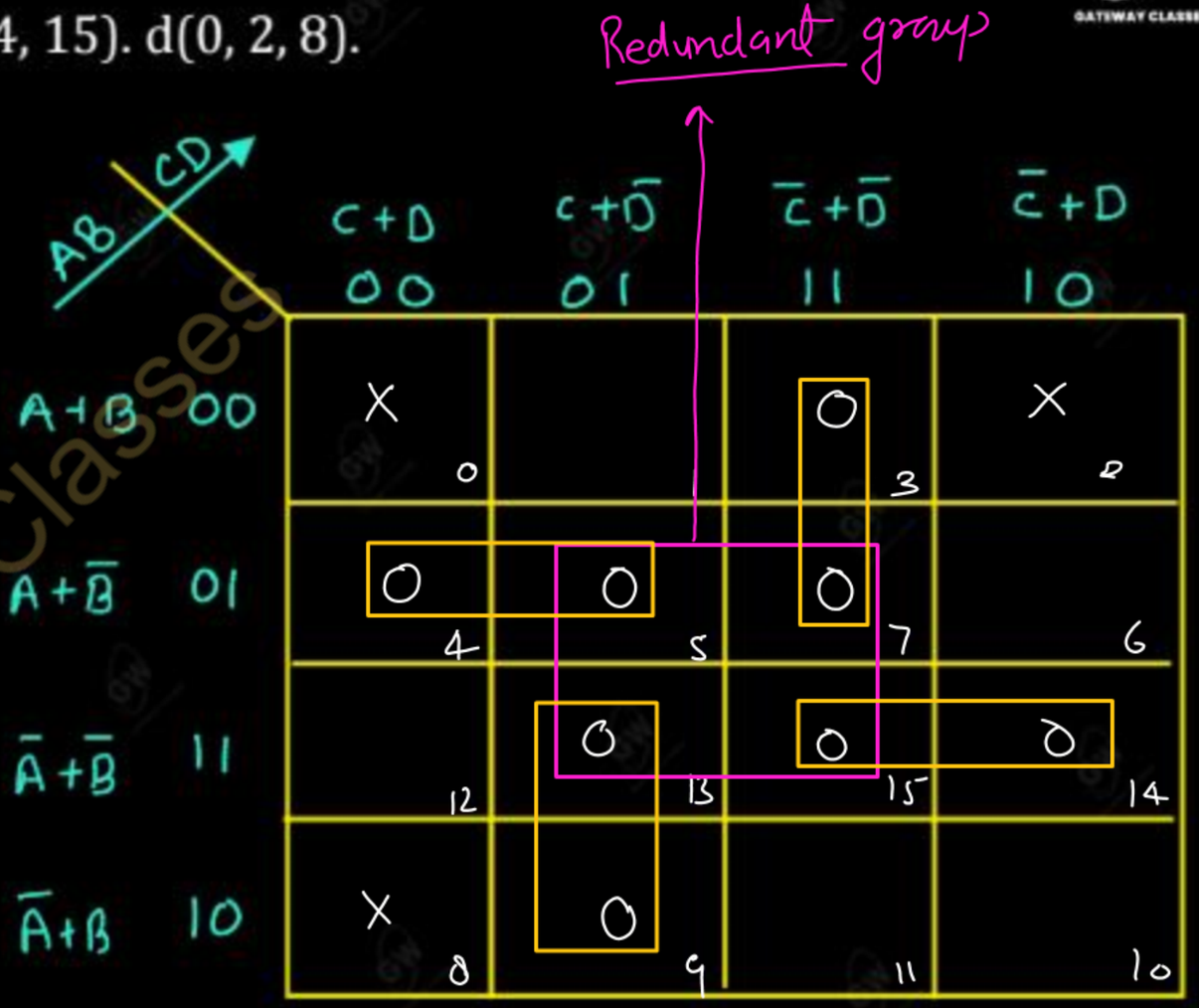
$$F = (A+\bar{B}+C) \cdot (A+\bar{C}+\bar{D}) \cdot (\bar{A}+C+\bar{D}) \cdot (\bar{A}+\bar{B}+\bar{C}) \left(\cdot (\bar{D}+\bar{B}) \right)_{\times}$$

Extra

Redundant Group (Ignore)

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

Ad



Gateway Classes

Unit-1 Lec-5

DPP

Q.1 State De Morgan's Law.

Q.2 Define minterm and maxterm.

Q.3 Minimize the following standard POS expression using K Map $Y = \Pi M (0, 2, 3, 5, 7)$

Q.4 Minimize the following expression using K Map $Y = \Sigma M (1, 5, 6, 7, 11, 12, 13, 15)$

Q.5 Simplify the Boolean Function $F = \sum m (0,1,2,5,7,8,9,10,13,15) + d (12,14)$ using K-map and implement the simplified expression using NAND gates only.

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