AKTU B.Tech II-Year

GATEWAY CLASSES

EC & EC Allied

DSD : Digital System Design

Unit-1 Lec-6

Gateway Classes



Today's target

- Tabulation method.
- PYQ
- DPP

Avinash Sir

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

Quine–McCluskey method (tabulation method)

- It is a systematic approach for minimizing Boolean functions, particularly useful when dealing with functions involving more than four variables.
- This method is advantageous over Karnaugh Maps (K-maps) in such scenarios due to its algorithmic nature, making it suitable for both manual calculations and computer implementations .

Advantages

- Systematic Approach: Provides a clear, step-by-step procedure for minimization.
- Scalability: More effective than K-maps for functions with a large number of variables.
- Computer Implementation: Its algorithmic nature makes it suitable for computer-based logic minimization tools.

Limitations

- Computational Complexity: The method can become computationally intensive for functions with a very large number of variables, as the number of possible prime implicants can grow exponentially .

Gateway Classes

Prime Implicant (PI)

prime implicant is a group of a minterms which cannot be combined with any other minterm or groups.

Essential Prime Implicant (EPI)

The essential prime implicant is a prime implicant in which one or more minterms are unique ,i.e it consist at least one minterm which is not contained in any other prime implicant. Tne Quine-McCluskey technique consists of two parts:

(i) First is to find all the prime implicants by an exhaustive search.

(ii) To identify the essential prime implicants obtained in part i and select from them the remaining prime implicants which can give the perfectly minimized expression.

Gateway Classes



The method involves the following key steps:

1) List Minterms: Begin by listing all the minterms (i.e., combinations of variables where the function outputs of the Boolean function.

2) Group Minterms: Organize these minterms based on the number of ones in their binary representation.

3) Combine Minterms: Iteratively combine minterms that differ by only one bit, replacing the differing bit with a dash (–) to indicate a don't-care condition. This process identifies the prime implicants.

4) Prime Implicant Chart: Construct a chart to determine which prime implicants cover which minterms.

5) Select Essential Prime Implicants: Identify and select essential prime implicants that cover minterms not covered by any other implicant.

6) Derive Simplified Expression: Use the selected prime implicants to write the minimized Boolean expression.

This method ensures a systematic and deterministic approach to Boolean function minimization, which is particularly beneficial for complex functions .

Gateway Classes

Q.1 Simplify the following function using Tabular method

$$F(A, B, C, D) = \Sigma m(0, 1, 3, 7, 8, 9, 11, 15)$$

0000
0001
0011
0111
1000
1001
1011
1111

Group	Minterm	A	B	C	D	
G-0	m_0	0	0	0	0	✓
G-1	m_1	0	0	0	1	✓
	m_8	1	0	0	0	✓
G-2	m_3	0	0	1	1	✓
	m_9	1	0	0	1	✓
G-3	m_7	0	1	1	1	✓
	m_{11}	1	0	1	1	✓
G-4	m_{15}	1	1	1	1	✓

Group	Minterm	A	B	C	D	
G0	$m_0 - m_1$	0	0	0	—	✓
	$m_0 - m_8$	—	0	0	0	✓
G1	$m_1 - m_3$	0	0	—	1	✓
	$m_1 - m_9$	—	0	0	1	✓
	$m_8 - m_9$	1	0	0	—	✓
G2	$m_3 - m_7$	0	—	1	1	✓
	$m_3 - m_{11}$	—	0	1	1	✓
	$m_9 - m_{11}$	1	0	—	1	✓
G3	$m_7 - m_{15}$	—	1	1	1	✓
	$m_{11} - m_{15}$	1	—	1	1	✓

Gateway Classes

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

Group	Minterm	A	B	C	D	
G0	m_0-m_1-m_8-m_9	—	0	0	—	$\bar{B}\bar{C}$
	m_0-m_8-m_1-m_9	—	0	0	—	$\bar{B}\bar{C}$
G1	m_1-m_3-m_9-m_{11}	—	0	—	1	$\bar{B}D$
	m_1-m_9-m_3-m_{11}	—	0	—	1	$\bar{B}D$
G2	m_3-m_7-m_{11}-m_{15}	—	—	1	1	CD
	m_3-m_{11}-m_7-m_{15}	—	—	1	1	CD

PI

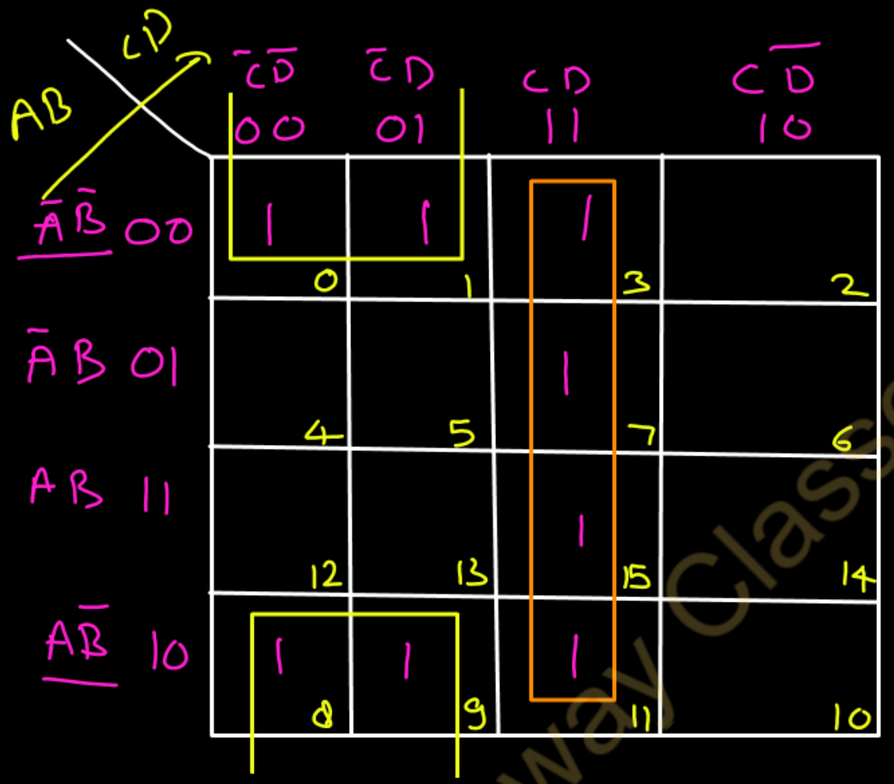
Final Simplified Expression

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

P.I	Minterms involve in PI	Essential P.I Given Minterms							
		0	1	3	7	8	9	11	15
$\bar{B}\bar{C}$	0,1,8,9	(X)	X			(X)	X		
$\bar{B}D$	1,3,9,11		X	X			X	X	
CD	3,7,11,15			X	(X)			X	(X)

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Gateway Classes

Verified by K map



$F = \bar{B}\bar{C} + CD$

OK

Gateway Classes

Q.2 Simplify the following function using Tabular method

Practice $Y(A, B, C, D) = \Sigma m(0, 1, 2, 3, 5, 7, 8, 9, 11, 14)$

Group	Minterm	A	B	C	D	
	m_0					
	m_1					

Group	Minterm	A	B	C	D

Gateway Classes

Group	Minterm	A B C D	

Gateway Classes

Q.3 Simplify the logic function using Tabular method

$$f(A, B, C, D) = \sum m\,(0, 1, 4, 6, 8, 9, 10, 12) + d(5, 7, 14).$$

Group	Minterm	A	B	C	D	
G_0	m_0	0	0	0	0	✓
G_1	m_1	0	0	0	1	✓
	m_4	0	1	0	0	✓
	m_8	1	0	0	0	✓
G_2	m_5*	0	1	0	1	✓
	m_6	0	1	1	0	✓
	m_9	1	0	0	1	✓
	m_{10}	1	0	1	0	✓
	m_{12}	1	1	0	0	✓
G_3	m_7*	0	1	1	1	✓
	m_{14}*	1	1	1	0	

0 0 0 0 0 ✓
1 ✓ 0 0 0 1
4 ✓ 0 1 0 0
6 0 1 1 0
8 ✓ 1 0 0 0
9 1 0 0 1
10 1 0 1 0
12 1 1 0 0
5 0 1 0 1
7 0 1 1 1
A 1 1 1 0

Group	Minterm	A	B	C	D	
G_0	$m_0 - m_1$	0	0	0	—	✓
	$m_0 - m_4$	0	—	0	0	✓
	$m_0 - m_8$	—	0	0	0	✓
G_1	$m_1 - m_5$	0	—	0	1	✓
	$m_1 - m_9$	—	0	0	1	✓
	$m_4 - m_5$	0	1	0	—	✓
	$m_4 - m_6$	0	1	—	0	✓
	$m_4 - m_{12}$	—	1	0	0	✓
	$m_8 - m_9$	1	0	0	—	✓
	$m_8 - m_{10}$	1	0	—	0	✓
	$m_8 - m_{12}$	1	—	0	0	✓
G_2	$m_5 - m_7$	0	1	—	1	✓
	$m_6 - m_7$	0	1	1	—	✓
	$m_6 - m_{14}$	—	1	1	0	✓
	$m_{10} - m_{14}$	1	—	1	0	✓
	$m_{12} - m_{14}$	1	1	—	0	✓

Gateway Classes

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

$\underline{0}, \underline{1}, (\underline{4}, \underline{6}), \underline{8}, \underline{9}, \underline{10}, \underline{12}$

Don't use don't care in this table.

Group	Minterm	A	B	C	D	
G0	$m_0 - m_1 - m_4 - m_5$	0	—	0	—	$\times \bar{A}\bar{C}$
	$m_0 - m_1 - m_8 - m_9$	—	0	0	—	$\times \bar{B}\bar{C}$
	$m_0 - m_4 - m_1 - m_5$	0	—	0	—	$\times \bar{A}\bar{C}$
	$m_0 - m_4 - m_8 - m_{12}$	—	—	0	0	$\times \bar{C}\bar{D}$
	$m_0 - m_8 - m_1 - m_9$	—	0	0	—	$\times \bar{B}\bar{C}$
	$m_0 - m_8 - m_4 - m_{12}$	—	—	0	0	$\times \bar{C}\bar{D}$
G1	$m_4 - m_5 - m_6 - m_7$	0	1	—	—	$\bar{A}B$
	$m_4 - m_6 - m_5 - m_7$	0	1	—	—	$\bar{A}B$
	$m_4 - m_6 - m_{12} - m_{14}$	—	1	—	0	$B\bar{D}$
	$m_4 - m_{12} - m_6 - m_{14}$	—	1	—	0	$B\bar{D}$
	$m_8 - m_{10} - m_{12} - m_{14}$	1	—	—	0	$A\bar{D}$
	$m_8 - m_{12} - m_{10} - m_{14}$	1	—	—	0	$A\bar{D}$

PI	Minterm involved in PI	Essential PI							
		0	1	4	6	8	9	10	12
$\bar{A}\bar{C}$	0, 1, 4, 5	×	×	×					
$\bar{B}\bar{C}$	0, 1, 8, 9	×	×			×	×		
$\bar{C}\bar{D}$	0, 4, 8, 12	×		×		×			×
$\bar{A}B$	4, 5, 6, 7			×	×				
$B\bar{D}$	4, 6, 12, 14			×	×				×
$A\bar{D}$	8, 10, 12, 14					×		×	×

$\bar{B}\bar{C} = 0, 1, 8, 9$

$A\bar{D} = 8, 10, 12, 14$

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

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

Ans.

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Q.4 Minimize $y = \sum m(0,1,2,3,5,6,7,8,14,15) + d(4,11,13)$ using tabular method

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Grp	Minterm	A	B	C	D
G_0	m_0	0	0	0	0
G_1	m_1	0	0	0	1
	m_2	0	0	1	0
	m_4	0	1	0	0
	m_8	1	0	0	0
G_2	m_3	0	0	1	1
	m_5	0	1	0	1
	m_6	0	1	1	0
G_3	m_7	0	1	1	1
	m_{11}	1	0	1	1
	m_{13}	1	1	0	1
	m_{14}	1	1	1	0
G_4	m_{15}	1	1	1	1

Grp	Minterm	A	B	C	D
G_0	$m_0 - m_1$	0	0	0	—
	$m_0 - m_2$	0	0	—	0
	$m_0 - m_4$	0	—	0	0
$\bar{B}\bar{C}\bar{D}$	$m_0 - m_8$	—	0	0	0
G_1	$m_1 - m_3$	0	0	—	1
	$m_1 - m_5$	0	—	0	1
	$m_2 - m_3$	0	0	1	—
	$m_2 - m_6$	0	—	1	0
	$m_4 - m_5$	0	1	0	—
	$m_4 - m_6$	0	1	—	0
G_2	$m_3 - m_7$	0	—	1	1
	$m_3 - m_{11}$	—	0	1	1
	$m_5 - m_7$	0	1	—	1
	$m_5 - m_{13}$	—	1	0	1
	$m_6 - m_7$	0	1	1	—
	$m_6 - m_{14}$	—	1	1	0
G_3	$m_7 - m_{15}$	—	1	1	1
	$m_{11} - m_{15}$	1	—	1	1
	$m_{13} - m_{15}$	1	1	—	1
	$m_{14} - m_{15}$	1	1	1	—

G.P	Minterm	A	B	C	D	
G_0	0-1-2-3	0	0	—	—	
	0-1-4-5	0	—	0	—	
	0-2-1-3	0	0	—	—	
	0-2-4-6	0	—	—	0	
	0-4-1-5	0	—	0	—	
	0-4-2-6	0	—	—	0	
G_1	1-3-5-7	0	—	—	1	
	1-5-3-7	0	—	—	1	
	2-3-6-7	0	—	1	—	
	2-6-3-7	0	—	1	—	
	4-5-6-7	0	1	—	—	
	4-6-5-7	0	1	—	—	
G_2	3-7-11-15	—	—	1	1	CD
	3-11-7-15	—	—	1	1	CD
	5-7-13-15	—	1	—	1	BD
	5-13-7-15	—	1	—	1	BD
	6-7-14-15	—	1	1	—	BC
	6-14-7-15	—	1	1	—	BC

0 0 0 0 0
1 0 0 0 1
2 0 0 1 0
3 0 0 1 1
5 0 1 0 1
6 0 1 1 0
7 0 1 1 1
8 1 0 0 0
14 1 1 1 0
15 1 1 1 1
4 0 1 0 0
11 1 0 1 1
13 1 1 0 1

0-8 ⇒ $\bar{B}\bar{C}\bar{D}$ 6-7-14-15 ⇒ BC
3-7-11-15 ⇒ CD , 5-7-13-14 ⇒ BD

Gateway Classes

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

$\bar{A} = 0, 1, 2, 3, 4, 5, 6, 7$

$\bar{B}\bar{C}\bar{D} = 0, 8$

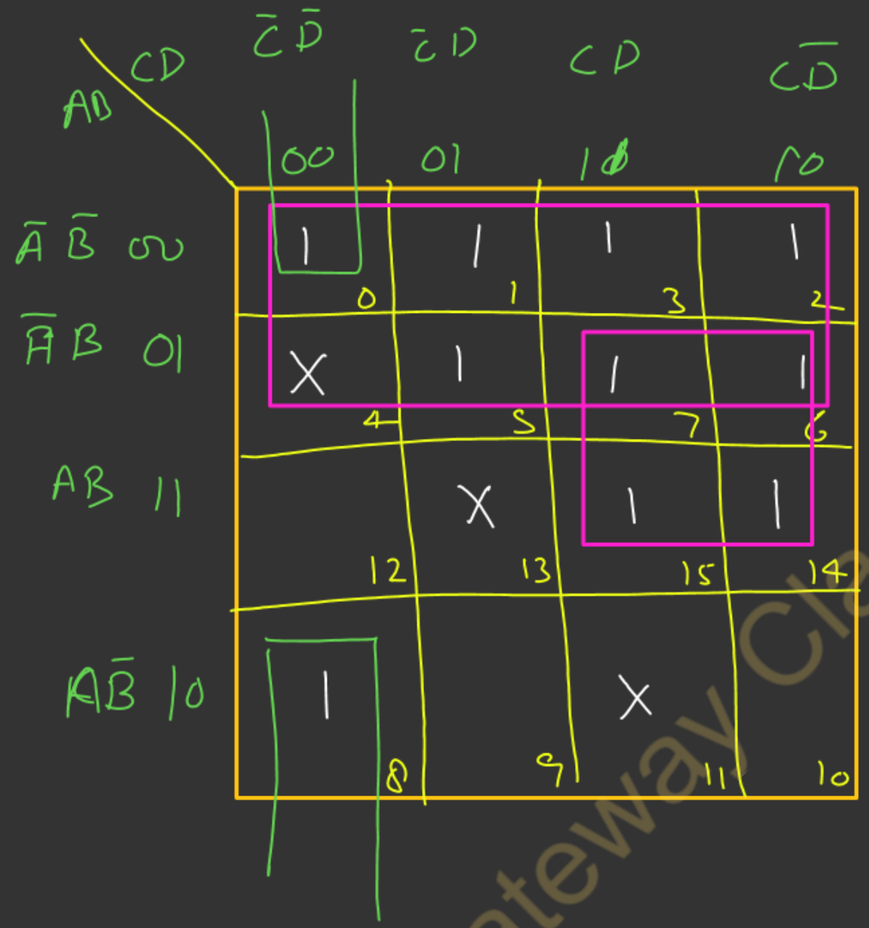
Grp	Minterm	A	B	C	D
G_0	0-1-2-3-4-5-6-7	0	—	—	—
	0-1-2-3-4-6-5-7	0	—	—	—
	0-1-4-5-2-3-6-7	0	—	—	—
	0-1-4-5-2-6-3-7	0	—	—	—
	0-2-1-3-4-5-6-7	0	—	—	—
	0-2-1-3-4-6-5-7	0	—	—	—
	0-2-4-6-1-3-5-7	0	—	—	—
	0-2-4-6-1-5-3-7	0	—	—	—
	0-4-1-5-2-3-6-7	0	—	—	—
	0-4-1-5-2-6-3-7	0	—	—	—
	0-4-2-6-1-3-5-7	0	—	—	—
	0-4-2-6-1-5-3-7	0	—	—	—

$\bar{A}$

PI	Minterm involved	Minterm used									
		0	1 ✓	2 ✓	3 ✓	5 ✓	6 ✓	7 ✓	8 ✓	14 ✗	15 ✗
$\bar{B}\bar{C}\bar{D}$	0, 8	X							X		
BC	6, 7, 14, 15						X	X		X	X
CD	3, 7, 11, 15				X			X			X
BD	5, 7, 13, 14					X		X		X	
$\bar{A}$	0, 1, 2, 3, 4, 5, 6, 7	X	X	X	X	X	X	X			

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

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Gateway Classes



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

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

Gateway Classes

Q.5 Minimize $y = \Pi M(2,7,8,9,10,12)$ IN SOP form using tabular method

or $Y = \Sigma m(0,1,3,4,5,6,11,13,14,15)$

0-15

0 0 0 0 0
1 0 0 0 1
3 0 0 1 1
4 0 1 0 0
5 0 1 0 1
6 0 1 1 0
11 1 0 1 1
13 1 1 0 1
14 1 1 1 0
15 1 1 1 1

GRP	Minterm	A	B	C	D
G_0	m_0	0	0	0	0 ✓
G_1	m_1	0	0	0	1 ✓
	m_4	0	1	0	0 ✓
G_2	m_3	0	0	1	1 ✓
	m_5	0	1	0	1 ✓
	m_6	0	1	1	0 ✓
G_3	m_{11}	1	0	1	1 ✓
	m_{13}	1	1	0	1 ✓
	m_{14}	1	1	1	0 ✓
G_4	m_{15}	1	1	1	1 ✓

GrP	Minterm	A	B	C	D	
G_0	$m_0 - m_1$	0	0	0	— ✓	
	$m_0 - m_4$	0	—	0	0 ✓	
G_1	$m_1 - m_3$	0	0	—	1 ✗	→ $\bar{A}\bar{B}D$
	$m_1 - m_5$	0	—	0	1 ✓	
	$m_4 - m_5$	0	1	0	— ✓	
	$m_4 - m_6$	0	1	—	0 ✗	→ $\bar{A}B\bar{D}$
G_2	$m_3 - m_{11}$	—	0	1	1 ✗	→ $\bar{B}CD$
	$m_5 - m_{13}$	—	1	0	1 ✗	→ $B\bar{C}D$
	$m_6 - m_{14}$	—	1	1	0 ✗	→ $BC\bar{D}$
G_3	$m_{11} - m_{15}$	1	—	1	1 ✗	→ ACD
	$m_{13} - m_{15}$	1	1	—	1 ✗	→ ABD
	$m_{14} - m_{15}$	1	1	1	— ✗	→ ABC

GrP	Minterm	A	B	C	D	
G_0	0-1-4-5	0	—	0	—	$\bar{A}\bar{C}$
	0-4-1-5	0	—	0	—	$\bar{A}\bar{C}$

PI

P.I

Gateway Classes

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

PI	Minterm involved	Minterm used									
		0 ✓	1 ✓	3	4 ✓	5 ✓	6	11	13	14	15
$\bar{A}\bar{B}D$	1, 3		X	X							
$\bar{A}B\bar{D}$	4, 6				X		X				
$\bar{B}CD$	3, 11			X				X			
$BC\bar{D}$	6, 14						X			X	
$B\bar{C}D$	5, 13					X			X		
ACD	11, 15							X			X
ABD	13, 15								X		X
ABC	14, 15									X	X
$\bar{A}\bar{C}$	0, 1, 4, 5	X	X		X	X					

$\bar{A}\bar{C} = 0, 1, 4, 5$

3, 6, 11, 13, 14, 15

$\bar{B}CD = 3, 11$

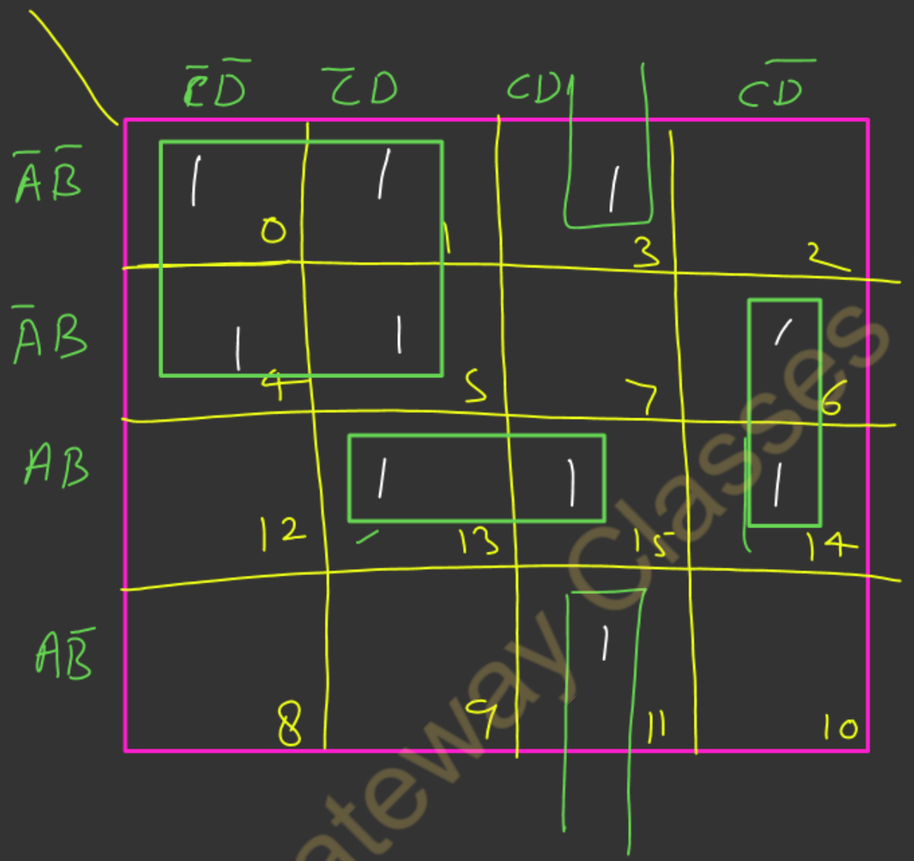
$BC\bar{D} = 6, 14$

$ABD = 13, 15$

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

Ans

Gateway Classes



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

Gateway Classes

Unit-1 Lec-6

DPP

Q.1 Simplify the following function using Tabular method

$Y(A, B, C, D) = \Sigma m(2, 4, 8, 11, 15) + d(1, 10, 12, 13)$

Q.2 Simplify the following function using Tabular method

$Y(A, B, C, D) = \Sigma m(0, 1, 2, 5, 7, 8, 9, 10, 13, 15)$

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