

K-Map [Karnaugh Map]

Simplification of Boolean Algebra for designing a circuit.

↳ Minimise the circuit,

↳ Important terms to understand

Implicants:- The group of 1's is called Implicant

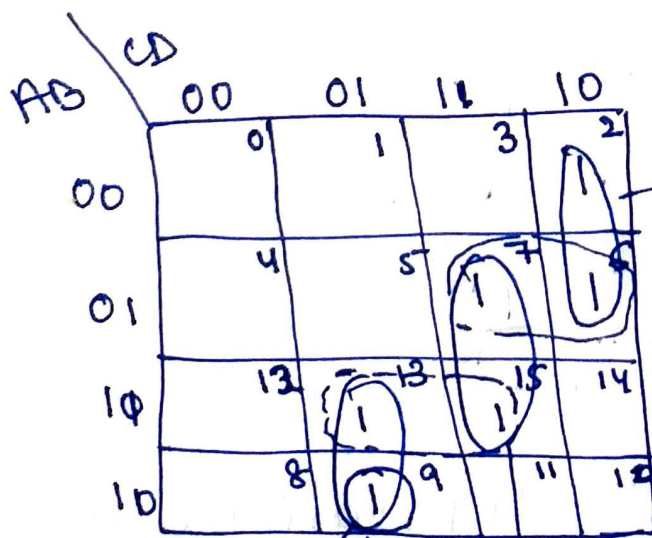
Ex:- 1, 2, 4, 8, 16 - - - etc.

Prime Implicants:- largest possible group of 1's

Essential Prime Implicants

Group of 1's, at least there is single 1 that cannot be combined in any other way.


Ex:-



Find out essential prime implicant

2 non-essential prime implicant

Cannot be combined

i) $\text{I} \rightarrow$ Prime Implicant, largest combn of 1
Can be , so essential prime implicant

II :- Prime Implicant

Non-essential Prime Implicant

III :- Prime Implicant

Essential Prime Implicant

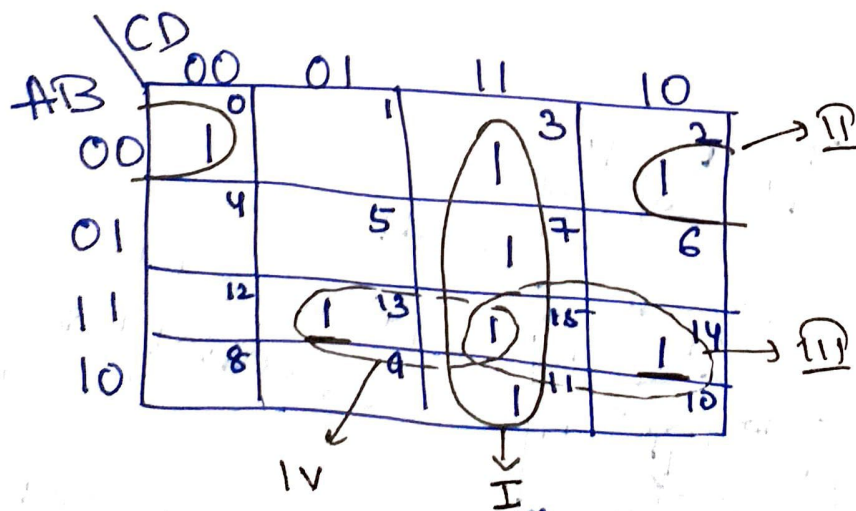
4-Variable k-Map

Ex:- $f(A, B, C, D) = \sum m(0, 2, 3, 7, 11, 13, 14, 15)$

↳ 4 variables

↳ 16 Combination (A is MSB, D is LSB)

$m_0 = 1, m_2 = 1, \dots, m_{15} = 1$



Best possible combn for 4 variable is 16, then
8 both are not there.

$$F = I + II + III + IV$$

I :- CD (AB not changing)

when two 1 → one literal is reduced, 4 → 2 literal is reduced

8, 3 literal is reduced, 14 is combined \rightarrow 4 literal are reduced.

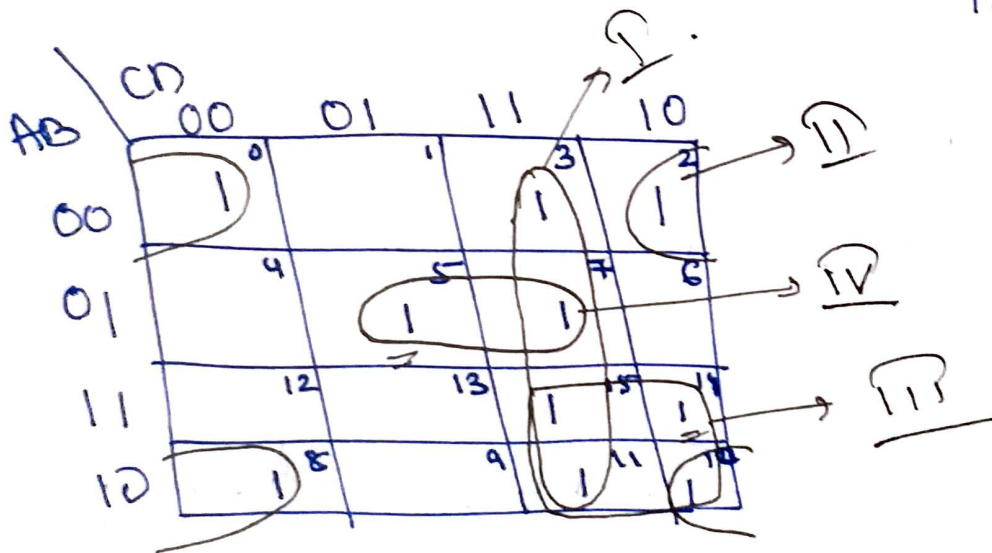
I:- $\bar{A}\bar{B}\bar{D}$

II:- ABC

IV:- ABD

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

Ex 1:- $F(A, B, C, D) = \sum m(0, 2, 3, 5, 7, 8, 10, 11, 14, 15)$



$F = I + II + III + IV$

I:- CD

II:- $\bar{B}\bar{D}$

III:- AC

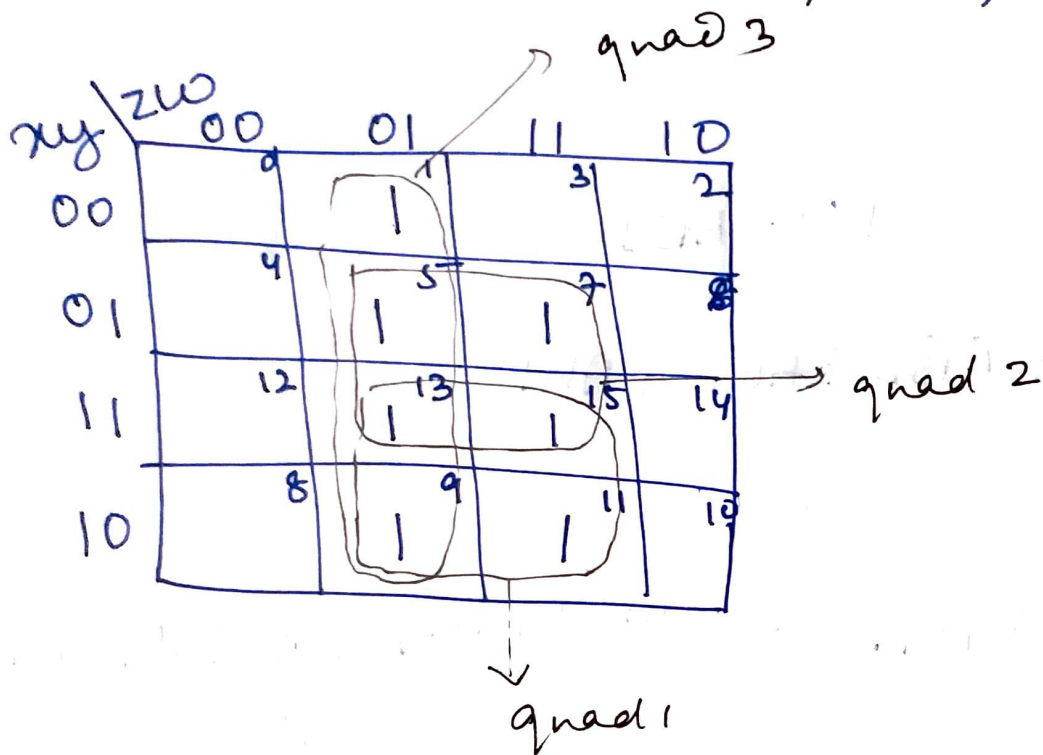
IV:- $\bar{A}BD$

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

Q

~~F(A,B)~~

$$F(x,y,z,w) = \sum m(1,5,7,9,11,13,15)$$

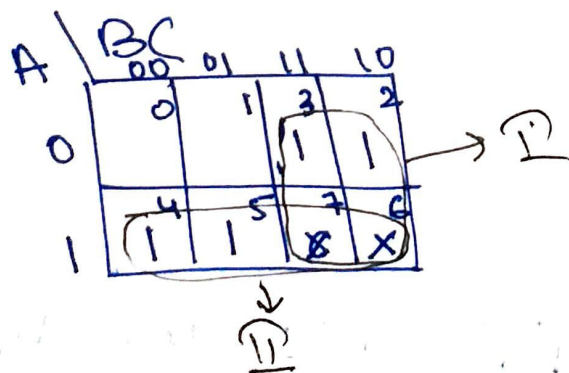


$$F = \text{quad 1} + \text{quad 2} + \text{quad 3}$$

$$= xw + yw + \bar{z}w$$

Q

$$F(A,B,C) = \sum m(2,3,4,5) + \sum d(6,7)$$



don't care

$$F = B + A$$

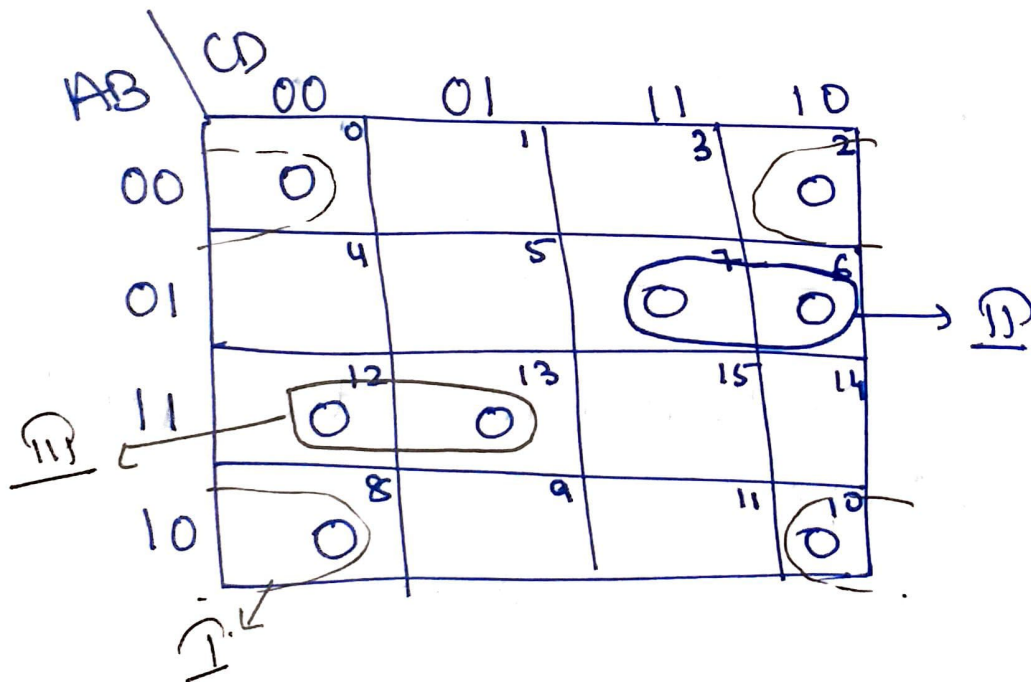
K-Map with Maxterms

↳ group of 0's

↳ $F(A, B, C, D) = \sum m(1, 3, 4, 5, 9, 11, 14, 15)$
get the POS or Max terms.

Soln:-

$$F(A, B, C, D) = \prod M(0, 2, 6, 7, 8, 10, 12, 13)$$



$$F' = I + II + III$$

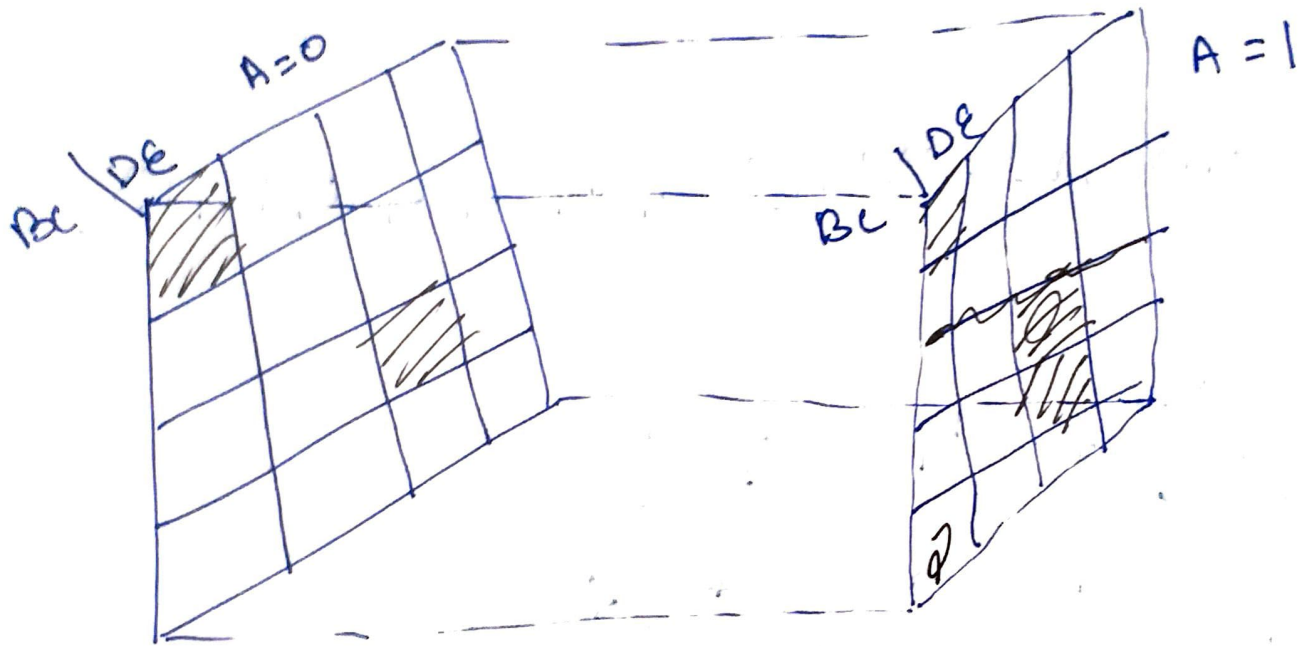
$$\overline{F'} = \overline{B}\overline{D} + \overline{A}BC + AB\overline{C}$$

So to get F , complement both sides

$$\begin{aligned}\overline{\overline{F}} &= \overline{\overline{B}\overline{D} + \overline{A}BC + AB\overline{C}} \\ &= (B+D)(A+\overline{B}+\overline{C})(\overline{A}+\overline{B}+C)\end{aligned}$$

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

K-Map with 5 Variables



↳ A K-Map 5 variable is constructed by using 2- 4-Variable Maps.

↳ 5 Variables = $2^5 = 32$ combⁿ.

A	B	C	D	E
0	0	0	0	0

⋮

0	1	1	1	1
---	---	---	---	---

1	0	0	0	0
---	---	---	---	---

⋮

1	1	1	1	1
---	---	---	---	---

} 16 cells.

} 16 cells.

We will make 2 k-Maps of 16 cells

BC \ DE	00	01	11	10
00				
01				
11				
10				

$A = 0$

BC \ DE	00	01	11	10
00				
01				
11				
10				

$A = 1$

Q $F(PQRST) = \sum (0, 2, 4, 7, 8, 10, 12, 16, 18, 20, 23, 24, 25, 26, 27, 28)$

QR \ ST	00	01	11	10
00	1		3	2
01	1	5	7	6
11	1	13	15	14
10	1	9	11	10

$A = 0$

QR \ ST	00	01	11	10
00	1	17	19	18
01	1	21	23	22
11	1	29	31	30
10	1	25	27	26

$A = 1$

$$\begin{array}{c|c} \text{ST} & 00 \\ \hline \text{QR} & \end{array} = \overline{P} \overline{Q} \overline{R} \overline{S} \overline{T}$$

$$P = 0$$

$$\underline{\text{I}} \rightarrow \bar{S}\bar{T} +$$

$$\underline{\text{II}} \rightarrow \bar{R} + \bar{T}$$

$$\underline{\text{III}} \rightarrow \bar{Q}RST$$

$$\underline{\text{IV}} \rightarrow PQR$$

$$\underline{\underline{Q}} F(A, B, C, D, E) = \sum m(0, 2, 4, 6, 9, 13, 21, 23, 25, 29, 31)$$

$$\underline{\underline{Q}} F(A, B, C, D, E) = \sum m(0, 1, 4, 5, 8, 9, 10, 11, 16, 17, 19, 20, 21, 23, 27, 31)$$

$$\underline{\underline{Q}} f(A, B, C) = \sum m(0, 1, 5, 6, 7)$$