Reading minimal form :-

- Cover all the minterm with minimum number of subcubes and each subcube must be as big as possible.

Q: Identify the number of prime implicants, Essential P I and write all possible minimal expression.

$$f(x,y,z) = \sum m(0,2,3,4,5,7)$$

$x \backslash yz$	00	01	11	10
0	1 (0)	(1)	1 (3)	1 (2)
1	1 (4)	1 (5)	1 (7)	(6)

PI = 6

EPI = 0

__Prime implicants -__

$h_1 = \bar{y}\bar{z}$ (0, 4)

$h_2 = x\bar{y}$ (4, 5)

$h_3 = xz$ (5, 7)

$h_4 = yz$ (3, 7)

$h_5 = \bar{x}y$ (2, 3)

$h_6 = \bar{x}\bar{z}$ (0, 2)

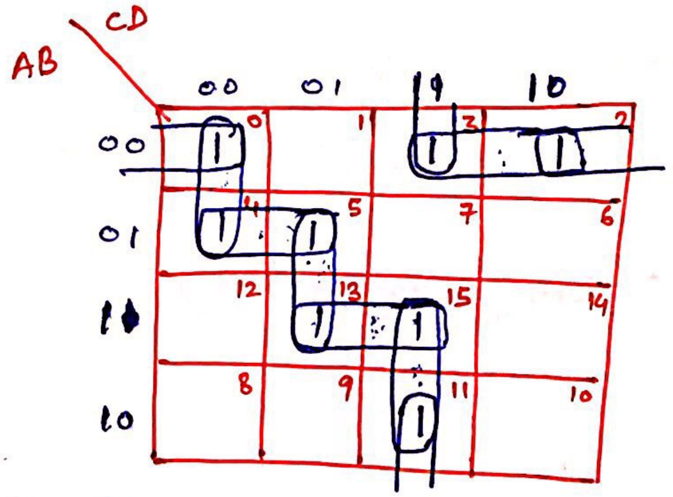
__Minimal expression :-__

$$f = \underbrace{\bar{y}\bar{z}}_{h_1} + \underbrace{xz}_{h_3} + \underbrace{\bar{x}y}_{h_5}$$

$$f = \underbrace{\bar{x}\bar{z}}_{h_6} + \underbrace{x\bar{y}}_{h_2} + \underbrace{yz}_{h_4}$$

* Every minterm is covered by 2 prime implicants ~~and these~~ thus corresponding K-map is called as __cyclic PI K-map.__

Q: Develop a 4-variable funcⁿ with 8 minterms and the K-map must be cyclic PI K-map. For the above funcⁿ identify the number of PI, EPI, and all possible minimal expression.



PI = 8

EPI = 0

$$f(A,B,C,D) = \Sigma m(0,2,3,4,5,11,13,15)$$

$$f_1 = \bar{A}\bar{C}\bar{D} + B\bar{C}D + ACD + \bar{A}\bar{B}C$$

$$f_2 = \bar{A}B\bar{C} + ABD + \bar{B}CD + \bar{A}\bar{B}\bar{D}$$

NOTE:-

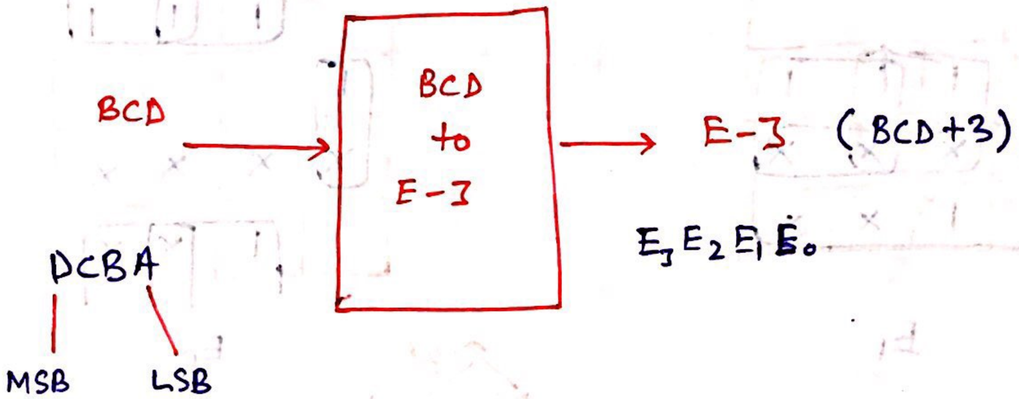
If the funcⁿ is having cyclic PI K-map;

- no. of PI = no. of minterms
- no. of EPI = 0
- Each PI is having $(n-1)$ no. of literals in its product form where n is no. of variables in the given function.
- Functⁿ has having 2 minimal forms.

- no. of terms in minimal expression = half of no. of PI

- There is no common PI among two minimal expression.

Q. Design and realize BCD to excess-3 code convertor.



$$\left[\begin{array}{l} BCD = \{0, 1, 2, \ldots 9\} \\ E\text{-}3 = \{3, 4, 5, \ldots 12\} \end{array}\right.$$

Truth Table :-

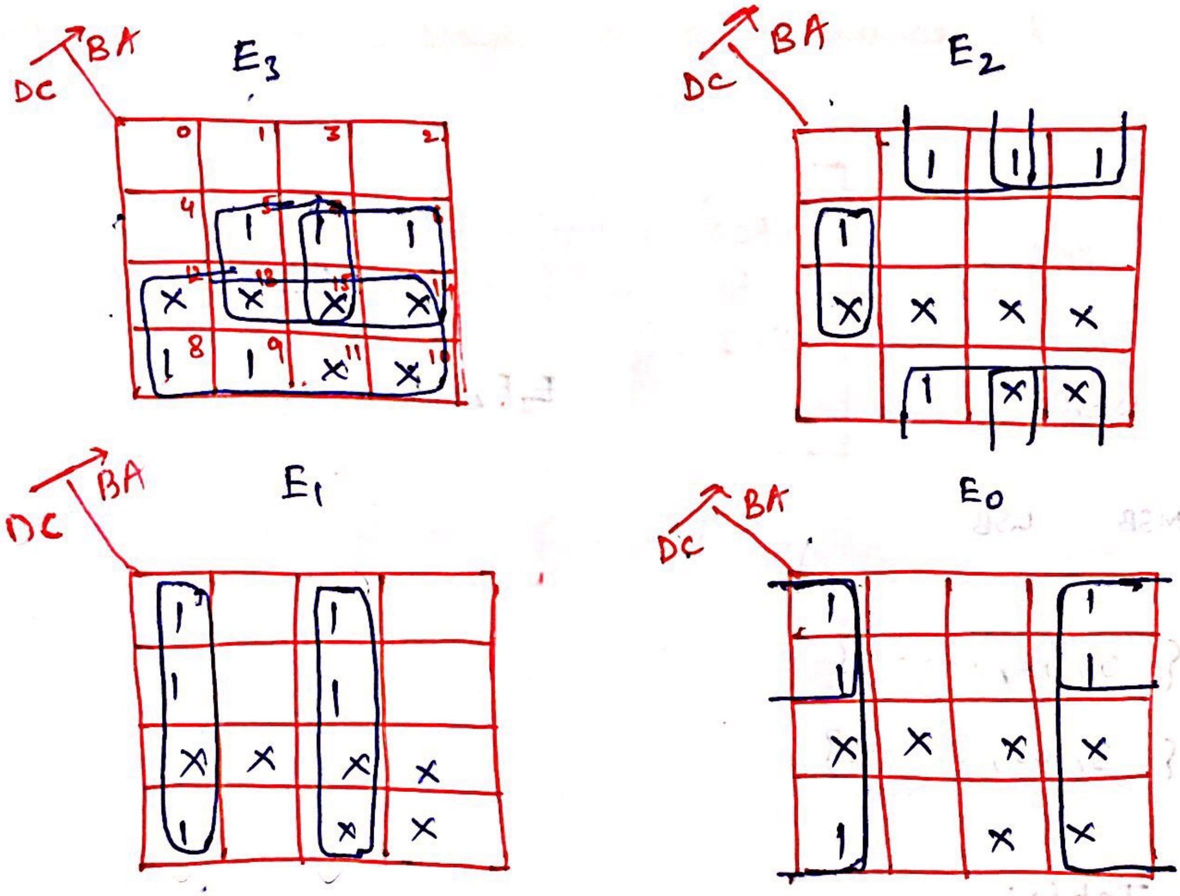
	D	C	B	A	E_3	E_2	E_1	E_0
0	0	0	0	0	0	0	1	1
1	0	0	0	1	0	1	0	0
2	0	0	1	0	0	1	0	1
3	0	0	1	1	0	1	1	0
4	0	1	0	0	0	1	ϕ	ϕ
5	0	1	0	1	1	0	0	0
6	0	1	1	0	1	0	0	1
7	0	1	1	1	1	0	1	0
8	1	0	0	0	1	0	1	1
9	1	0	0	1	1	1	0	0

$E_3(D,C,B,A) = \Sigma m(5,6,7,8,9) + d$

$E_2(D,C,B,A) = \Sigma m(1,2,3,4,9) + d$

$E_1(D,C,B,A) = \Sigma m(0,3,4,7,8) + d$

$E_0(D,C,B,A) = \Sigma m(0,2,4,6,8) + d$



(i) In some digital ckt, few of I/P combination may not be used by ckt.

OR

(ii) Few I/P combination ckt may not be responding

OR

(iii) For Few I/P combination o/p may be simply ignored

The above combination are called 'Don't care' combination.

As in case of BCD (0, 1, 2, ... 9) where $n = 4$ we have $2^4 = 16$ combination, but (10, 11, 12, ... 15) combination are not used so these are don't care combination.

$$\left(d = \Sigma m(10, 11, 12, 13, 14, 15)\right)$$

To cover the minterms while using "don't care" combinations, if the size of the subcube is coming large, such don't care are included in the subcube.

$$E_3 = D + CA + CB$$

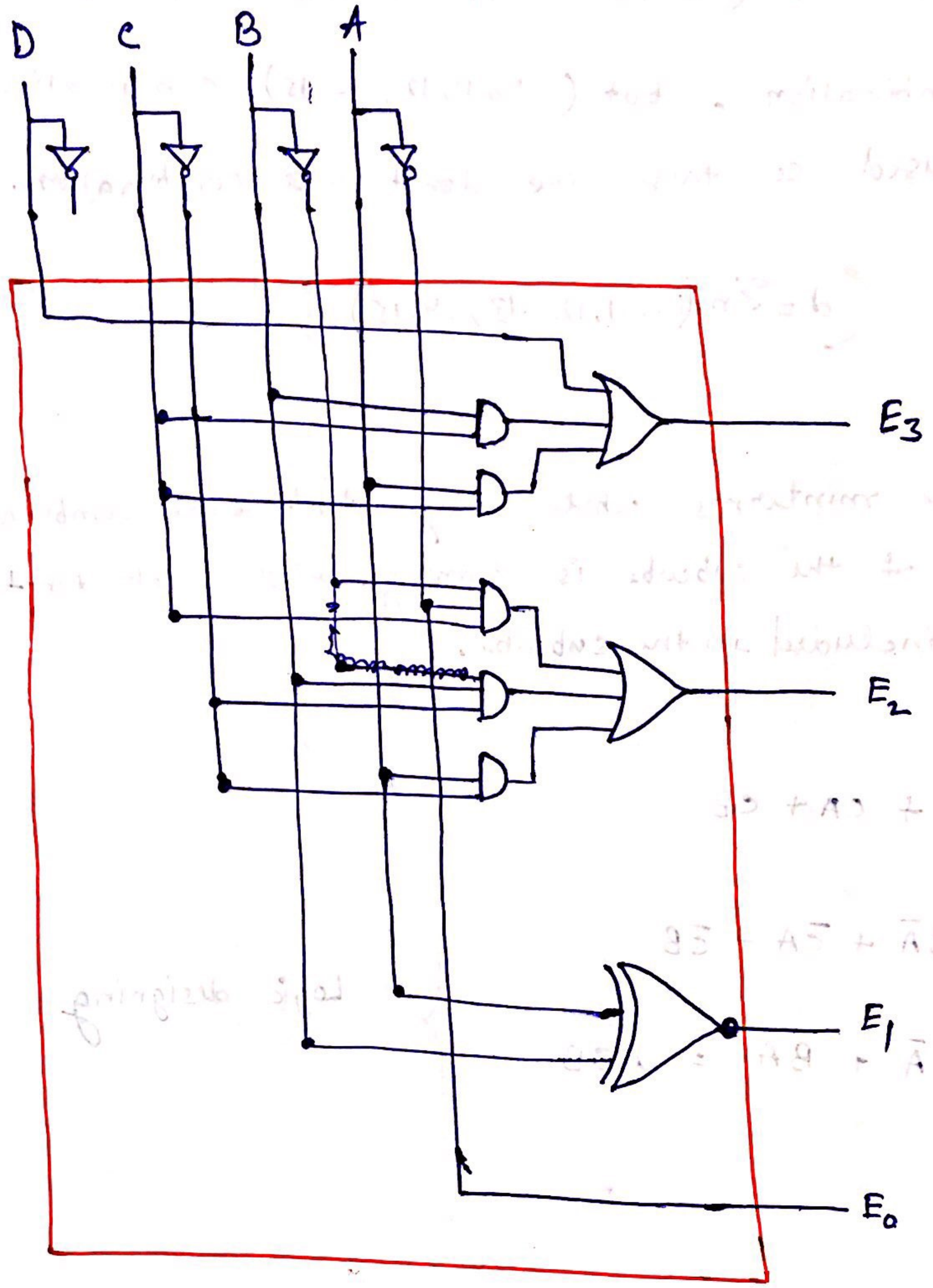
$$E_2 = C\bar{B}\bar{A} + \bar{C}A + \bar{C}B$$

$$E_1 = \bar{B}\bar{A} + BA = A \odot B$$

$$E_0 = \bar{A}$$

Logic designing

The process of analyzing truth table to generate the logic function is ~~nothing~~ known as gate designing.



Steps to Design ckt:-

(i) Read the Truth table

(ii) Generate canonical sop form using truth table.

(iii) Read minimal forms using K-maps.

(iv) Develop the logic ckt for minimal expression.

Advantage:-

(i) No. of logic gates is minimum.

(ii) Fan-in for logic gate is minimum.

(iii) Power consumption is less

(iv) Complexity of the ckt is less

(v) Cost of ckt is less.

Q. The func^n f_1 and f_2 are given below:

$$f_1(\cancel{A}\, w,x,y,z) = \Sigma m(1,4,5,9,12,14,15) + d(3,10)$$

$$f_1(w,x,y,z) = \Sigma m(0,2,3,5,11,12,15) + d(6,14)$$

(a) Find $f_3 = f_1 + f_2$

(b) $f_4 = f_1 \cdot f_2$

(c) $f_5 = f_1 \cdot \overline{f_2}$

m	f_1	f_2	$\overline{f_2}$	$f_3 = f_1 + f_2$	$f_4 = f_1 \cdot f_2$	$f_5 = f_1 \cdot \overline{f_2}$
0	0	1	0	1	0	0
1	1	0	1	1	0	1
2	0	1	0	1	0	0
3	X	1	0	1	X	0
4	1	0	1	1	0	1
5	1	1	0	1	1	0
6	0	X	X	X	0	0
7	0	0	1	0	0	0
8	0	0	1	0	0	0
9	1	0	1	1	0	1
10	X	0	1	X	0	X
11	0	1	0	1	0	0

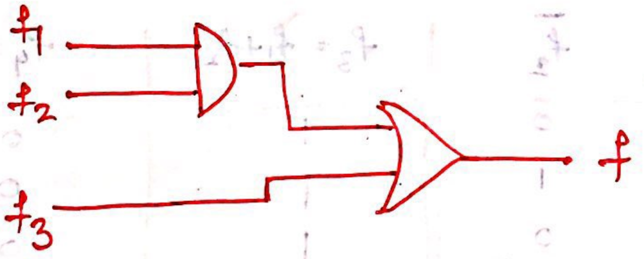
m	f_1	f_2	f_2'	f_3	f_4	f_5
12	ϕ	1	0	1	ϕ	0
13	0	0	1	0	0	0
14	1	X	X	1	X	X
15	1	1	0	1	1	0

$$f_3 = \Sigma m(0,1,2,3,4,5,9,11,12,14,15) + d(6,10)$$

$$f_4 = \Sigma m(5,12,15) + d(3,14)$$

$$f_5 = \Sigma m(1,4,9) + d(10,14)$$

Q. The given logic ckt realizing the func^n $f(w,x,y,z) = \Sigma m(1,4,7,9,10,12,15)$ and func^n $f_1(w,x,y,z) = w\bar{y} + x\bar{y}z + \bar{w}\bar{x}y$. Find f_2 and f_3.



$$f_1(w,x,y,z) = \overset{w\bar{y} + x\bar{y}z + \bar{w}\bar{x}y}{\cancel{\Sigma m(1,4,7,9,10,12,15)}}$$

$$= wx\bar{y} + w\bar{x}\bar{y} + wx\bar{y}z + \bar{w}x\bar{y}z + \bar{w}\bar{x}yz + \bar{w}\bar{x}y\bar{z}$$

$$f_1 = \overset{13}{wx\bar{y}z} + \overset{12}{wx\bar{y}\bar{z}} + \overset{9}{w\bar{x}\bar{y}z} + \overset{8}{w\bar{x}\bar{y}\bar{z}} + \overset{5\ \cancel{10}}{\bar{w}x\bar{y}z} + \underset{3}{\bar{w}\bar{x}yz} + \underset{2}{\bar{w}\bar{x}y\bar{z}}$$

$$f_1 = \Sigma m(2,3,5,8,9,\cancel{10},12,13)$$

$$f = f_1 \cdot f_2 + f_3$$

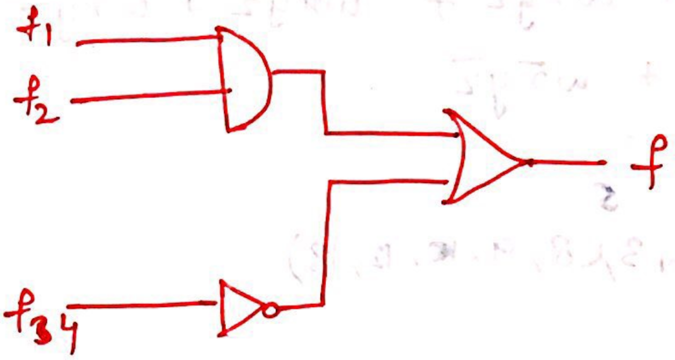
	f_1	f_2	f_3	f
0	0	X	0	0
1	0	X	1	1
2	1	0	0	0
3	1	0	0	0
4	0	X	1	1
5	1	0	0	0
6	0	X	0	0
7	0	X	1	1
8	1	0	0	0
9	1	1	$\cancel{X}$	1
10	0	X	1	1
11	0	X	0	0
12	1	1	X	1
13	1	0	0	0
14	0	X	0	0
15	0	X	1	1

$f_2 = \Sigma m(9,12) + d(0,1,4,6,7,10,11,14,15)$

$f_3 = \Sigma m(1,4,7,10,15) + d(9,12)$

Minterms of the f_2 are don't care of f_3

Q:



Find f_2 and f_4 , $f = \Sigma m(1, 4, 7, 9, 10, 12, 15)$

$f_1 = \Sigma m(2, 3, 5, 8, 9, 12, 13)$

$f_4 = \bar{f_3} = \Sigma m(0, 2, 3, 5, 6, 8, 11, 13, 14) + d(9, 12)$

Q: Find the minimal POS form for the func^n f:

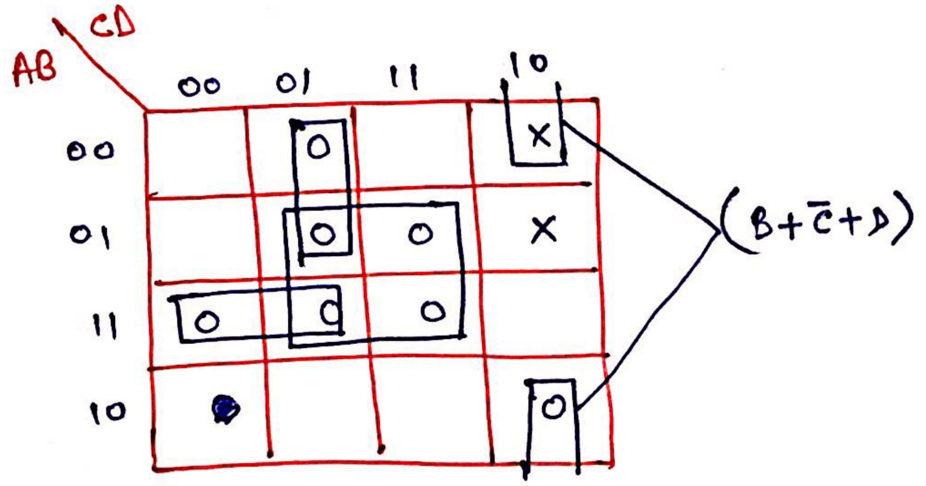
$f(A, B, C, D) = \Pi M(1, 5, 7, 10, 12, 13, 15)$

AB \ CD	00	01	11	10
00		Φ		
01		Φ	Φ	
11	Φ	Φ	Φ	
10				Φ

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

SOP $\longrightarrow$ Product term $\longrightarrow$ Prime Implicant

POS $\longrightarrow$ sum term $\longrightarrow$ False Prime Implicant



Q. Identify the number of minterms in the given func^n :

$$f(v, w, x, y, z) = y + xz$$

(a) 24 (b) 20 (c) 16 (d) 12