

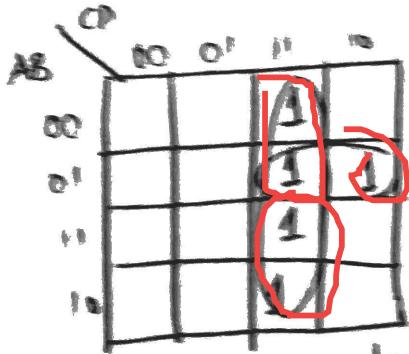
Roll Number: 16EE234Name : Megh Manoj BhaleraoI) PLA Implementation

$$f(A, B, C, D) = \sum_{\text{min}}(3, 6, 7, 11, 15)$$

$$g(A, B, C, D) = \sum_{\text{min}}(1, 3, 4, 7, 9, 13)$$

$$h(A, B, C, D) = \sum_{\text{min}}(4, 6, 8, 10, 11, 12, 14, 15)$$

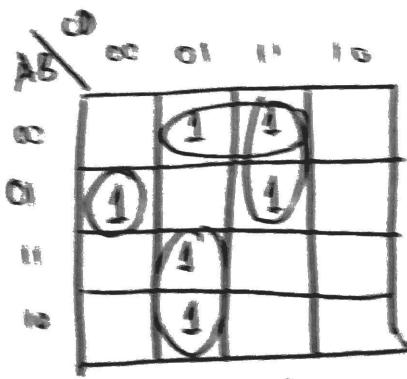
KMAP - f



Simplified expression:

$$f = \bar{A}B + CD$$

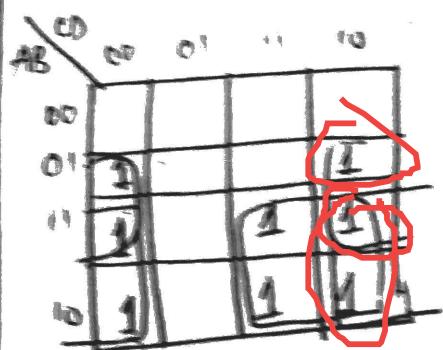
KMap - g



Simplified exp:

$$\begin{aligned} g = & \bar{A}\bar{B}D + \\ & \bar{A}CD + \\ & A\bar{C}D + \\ & \bar{A}B\bar{C}D \end{aligned}$$

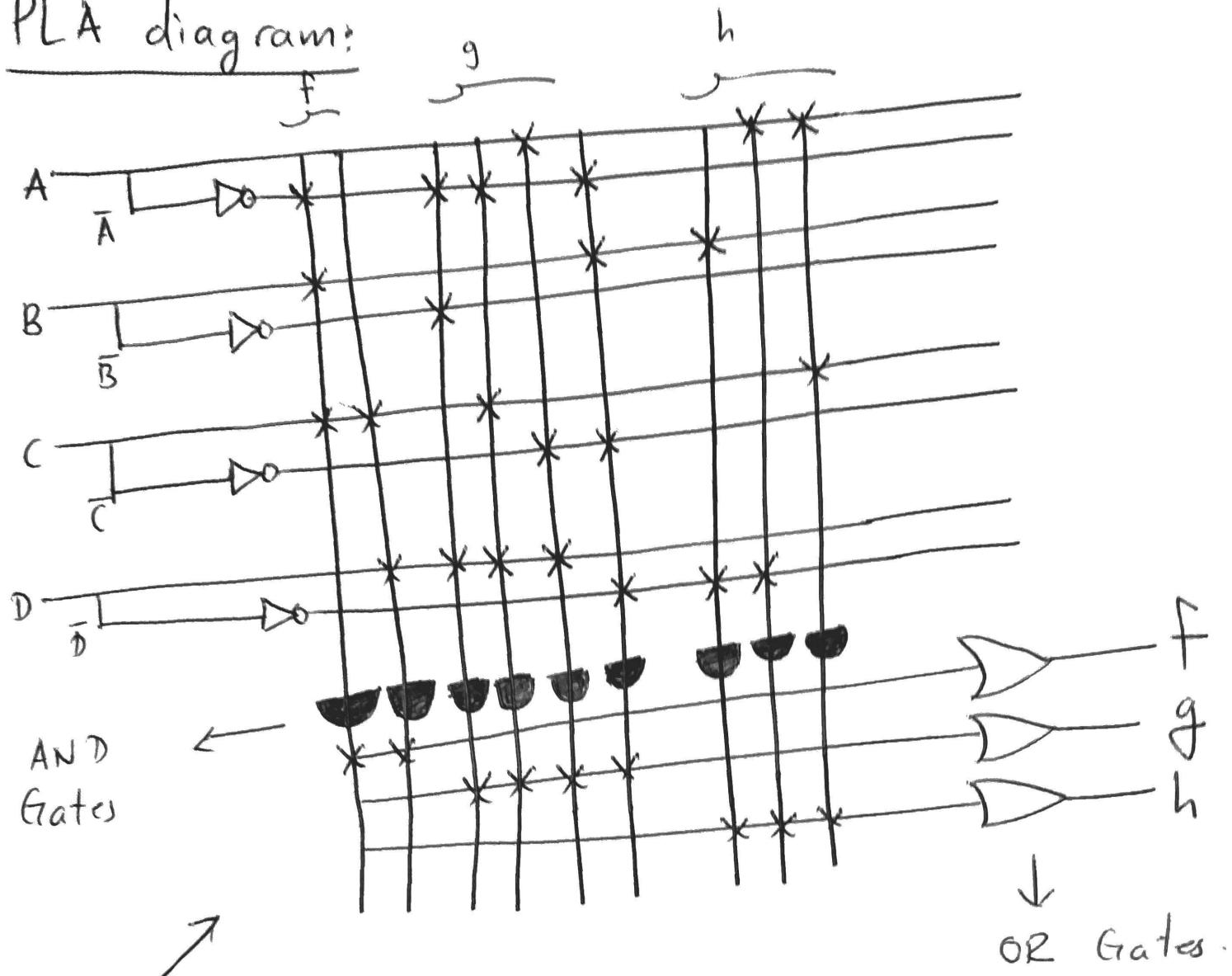
KMap - h



Simplified exp:

$$\begin{aligned} h = & B\bar{D} + A\bar{D} \\ & + AC \end{aligned}$$

PLA diagram:



Non-simplified Representation of PLA -

Uses 9 AND Gates \rightarrow 5

Using Simplified Version:

$$f = \bar{A}BC + CD$$

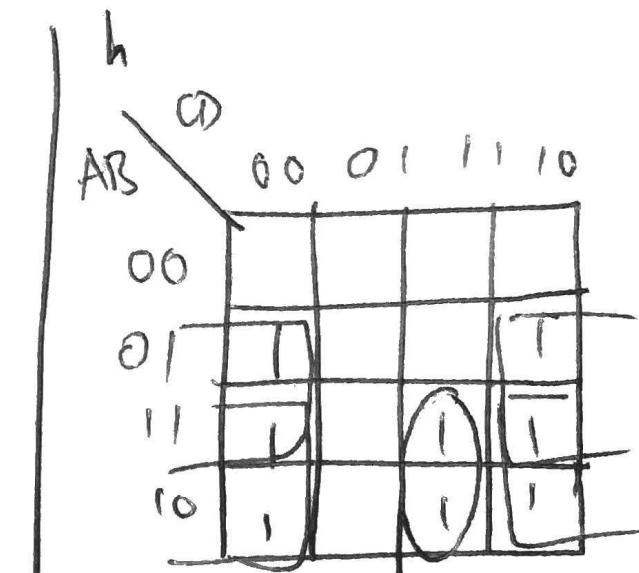
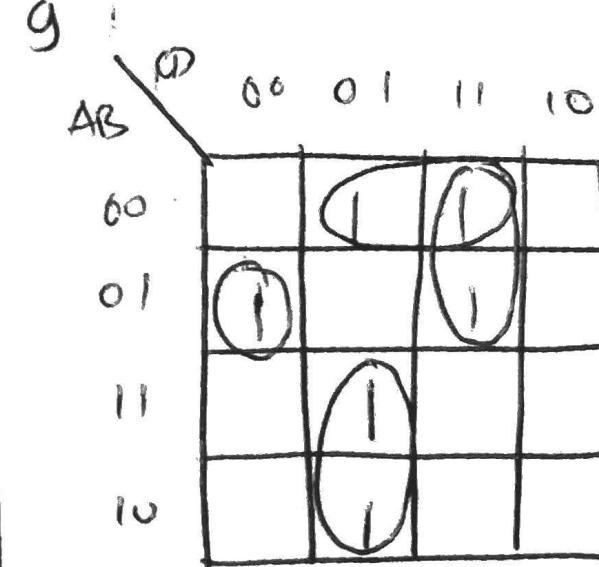
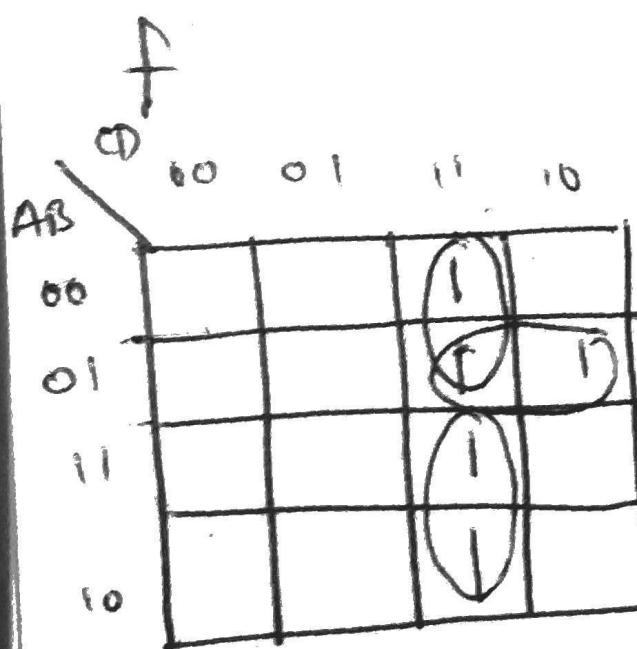
$$g = \bar{A}\bar{B}D + \bar{A}CD + A\bar{C}D + \bar{A}B\bar{C}\bar{D}$$

$$h = B\bar{D} + A\bar{D} + AC$$

Simplifying PLA for Q1

Draw K-Map again:

Has 8 terms



$$f = \overline{A} \overline{C} \overline{D}^{\textcircled{1}} + \overline{A} B C + \overline{A} C D^{\textcircled{2}}$$

$$g = \overline{A} \overline{B} \overline{C} \overline{D} + \overline{A} \overline{B} D + \overline{A} C \overline{D}^{\textcircled{1}} + \overline{A} \overline{C} D$$

$$h = \overline{A} C D^{\textcircled{2}} + B \overline{D} + A \overline{D}$$

PLA Table is (Simplified to 8-terms)

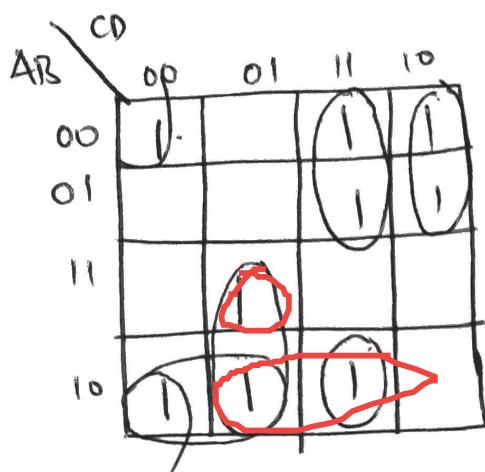
Term	Inputs				f	g	h
	A	B	C	D			
$\bar{A}CD$	0	-	1	1	1	1	0
$\bar{A}BC$	0	1	1	-	1	0	0
$A\cdot CD$	1	-	1	1	1	0	3
$\bar{A}B\bar{C}\bar{D}$	0	1	0	0	0	1	0
$\bar{A}\bar{B}D$	0	0	-	1	0	1	0
$\bar{A}CD$	aaaaaa						
$A\bar{C}D$	1	-	0	1	0	1	0
$B\bar{D}$	-	1	-	0	0	0	1
$A\bar{D}$	1	-	-	0	0	0	1

$$2) \text{ a) } f_1(A, B, C, D) = \sum m(0, 2, 3, 6, 7, 8, 9, 11, 13)$$

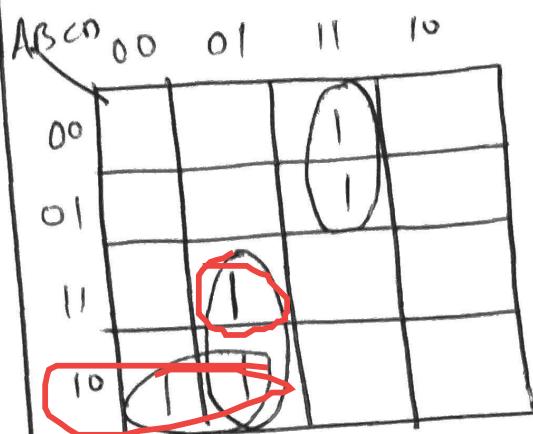
$$f_2(A, B, C, D) = \sum m(3, 7, 8, 9, 13)$$

$$f_3(A, B, C, D) = \sum m(0, 2, 4, 6, 8, 12, 13)$$

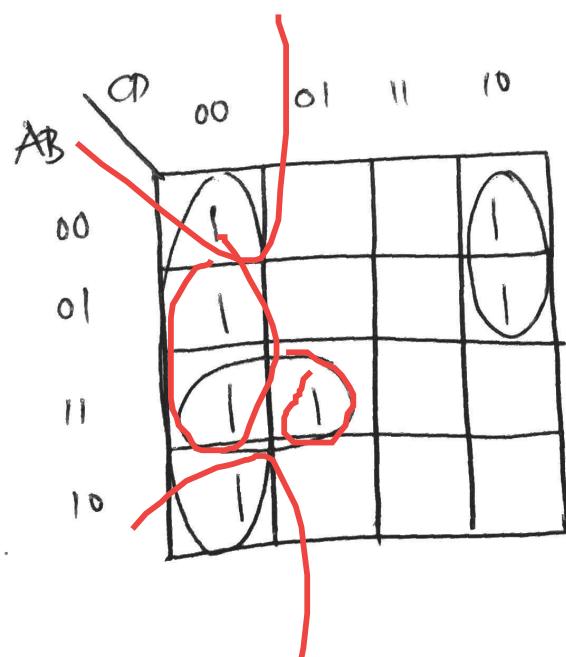
KMap f_1 :



KMap - f_2



K-Map f_3

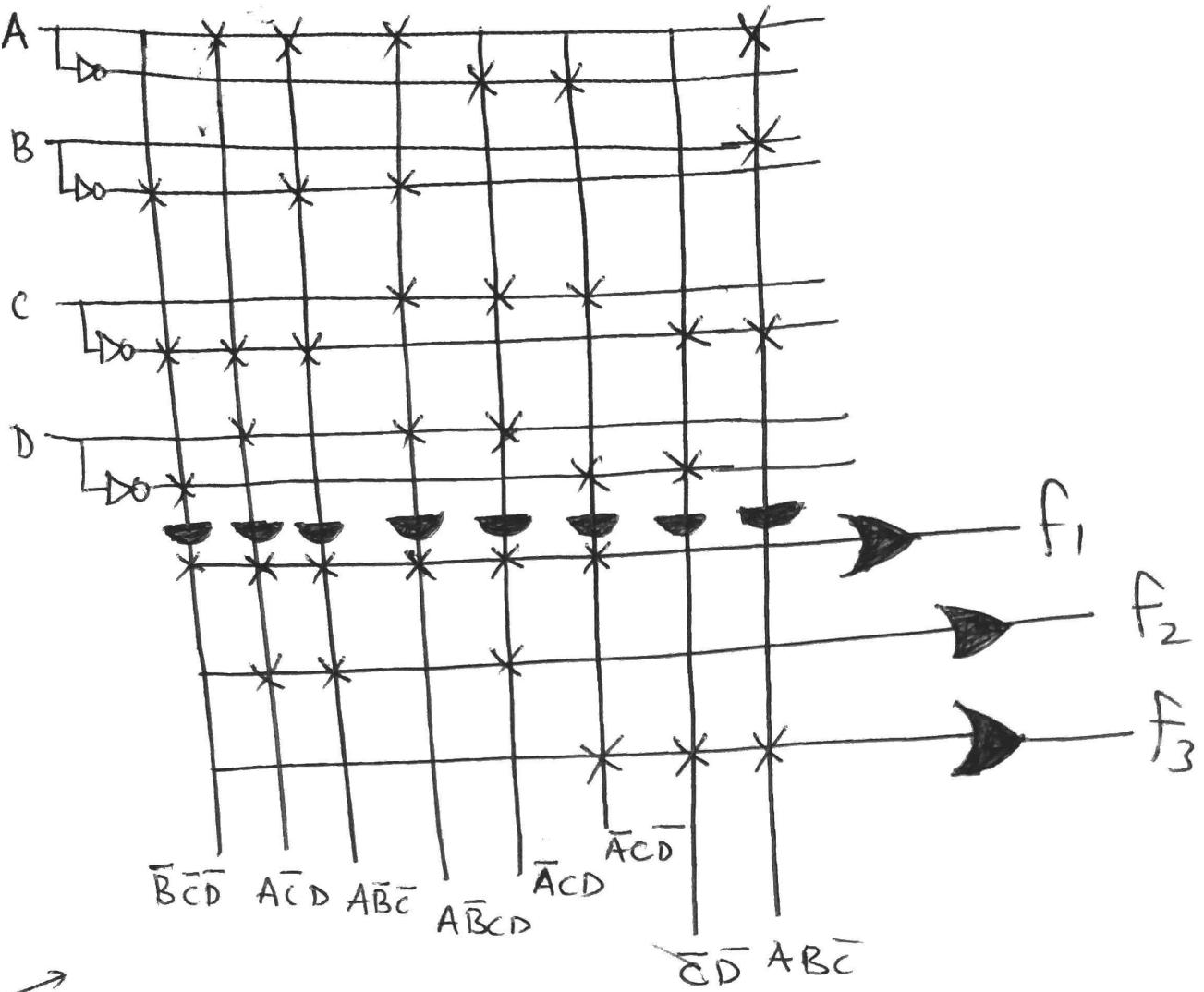


Expressions Simplified for each function (Such that combined # is least)

$$f_1 = \overline{B} \overline{C} \overline{D} + \underline{\overline{A} \overline{C} D^3} + \underline{\overline{A} \overline{B} \overline{C}^2} + \underline{\overline{A} \overline{B} C D} + \underline{\overline{A} C D^4} + \underline{\overline{A} C \overline{D}^1}$$

$$f_2 = \underline{\overline{A} \overline{B} \overline{C}^2} + \underline{\overline{A} \overline{C} D^3} + \underline{\overline{A} C D^4}$$

$$f_3 = \overline{C} \overline{D} + A \overline{B} \overline{C} + \underline{\overline{A} C \overline{D}^1}$$



PLA Diagram (Almost minimized) - 8 terms

Product term	Inputs				Outputs	
	A	B	C	D	f_1	f_2
$\bar{B}\bar{C}\bar{D}$	-	0	0	0	1	0
$A\bar{C}D$	1	-	0	1	1	0
$A\bar{B}\bar{C}$	1	0	0	-	1	1
$A\bar{B}CD$	1	0	1	1	1	0
$\bar{A}CD$	1	0	-	1	1	1
$\bar{A}C\bar{D}$	0	-	1	0	1	0
$\bar{C}\bar{D}$	-	-	0	0	0	1
$ABC\bar{C}$	1	1	0	-	0	1

$$2b) f_1(A, B, C, D) = cd + ad + \overline{a}b\overline{c}d$$

$$f_2(A, B, C, D) = b\bar{c}\bar{d} + \bar{a}\bar{c} + a\bar{d}$$

Make KMap for each of the expression $P(A)$.
and then find minimum row

$$f_1 = (a+\bar{a})(b+\bar{b})cd + a(b+\bar{b})^{(c+\bar{c})}d^{\bar{c}} + \bar{a}b\bar{c}\bar{d}$$

$$f = \cancel{ab\bar{c}d + \bar{a}\bar{b}cd + \bar{a}b\bar{c}d + \bar{a}\bar{b}cd} + \\ \bar{a}\bar{b}\bar{c}d + ab\bar{c}d + \bar{a}b\bar{c}\bar{d}$$

\bar{v}	\bar{ab}	\bar{cd}	\bar{cd}	cd	cd
\bar{ab}	\bar{ab}	0	0	1	0
\bar{ab}	\bar{ab}	1 ₄	0 ₅	1 ₃	0 ₆
ab	ab	0 ₁₂	1 ₁₃	1 ₁₅	0 ₁₄
\bar{ab}	\bar{ab}	0 ₈	1 ₉	1 ₁₀	0 ₁₀

$\bar{c}\bar{d}$	$\bar{c}d$	$c\bar{d}$	$c\bar{d}$
$a\bar{b}$	0, 0,	0, 3	0_2
$\bar{a}\bar{b}$	$\frac{1}{4}$, 0	0, 7	0, 6
$\bar{a}b$	1, $\frac{1}{11}$	0, 15	1, $\frac{1}{11}$
$a\bar{b}$	1, $\frac{1}{8}$	0, $\frac{1}{11}$	1, $\frac{1}{11}$

$$f_2 = ab\bar{c}\bar{d} + \bar{a}b\bar{c}\bar{d} + \\ a(b+\bar{b})\bar{c}(d+\bar{d}) + \\ a(b+\bar{b})(c+\bar{c})\bar{d}$$

$$\begin{aligned}
 &= \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d} + \\
 &\quad \checkmark \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d} + \\
 &\quad \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d} + \\
 &\quad \checkmark \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d} - \\
 &\quad \checkmark \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d} - \\
 &\quad \checkmark \overline{a} \overline{b} \overline{c} \overline{d} + \overline{a} \overline{b} \overline{c} \overline{d}
 \end{aligned}$$

Simplified Table using Espresso Algorithm is:

(Minimum Row PLA Table)

Expression/Term	Inputs				f_1	f_2
	A	B	C	D		
$\checkmark \bar{A}B\bar{C}\bar{D}$	0	1	0	0	1	0
$\bar{B}\bar{C}D$	-	1	0	1	0	1
$\checkmark CD$	-	-	1	1	1	0
$\checkmark A\bar{D}$	1	-	-	0	0	1
$\cdot A\bar{C}D$	1	-	0	1	1	1

Expression can be written as:

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

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

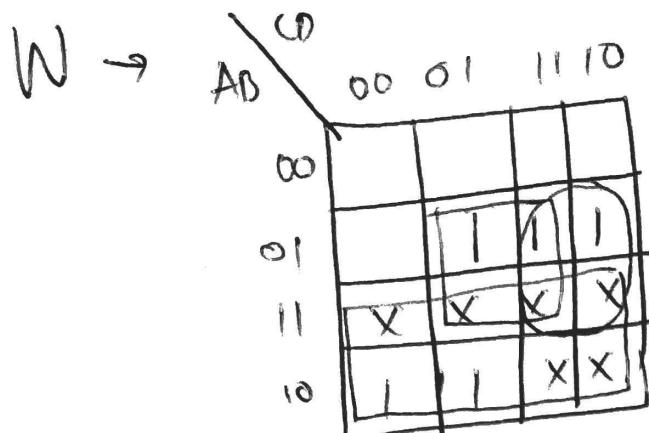
Common term

3) BCD to XS3 code converter:

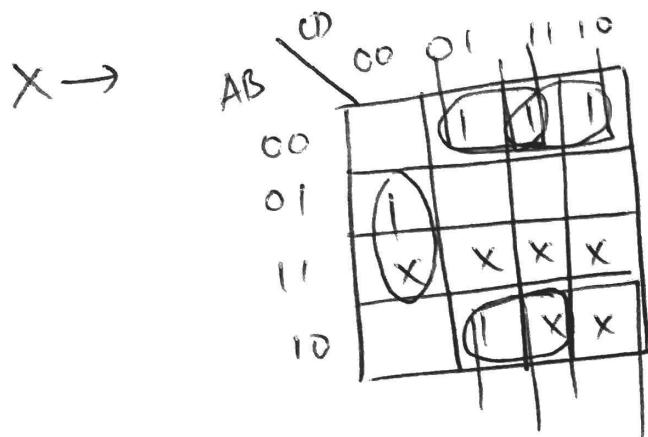
Truth table for BCD to XS3

BCD	XS3
A B C D	W X Y Z
0 0 0 0	0 0 11
0 0 0 1	01 00
0 0 1 0	01 01
0 0 1 1	01 10
0 1 0 0	0111
0 1 0 1	1000
0 1 1 0	1001
0 1 1 1	1010
1 0 0 0	1011
1 0 0 1	10100
1 0 1 0	*X XX
1 0 1 1	XX X*
1 1 0 0	XXXX
1 1 0 1	XXX*
1 1 1 0	XXX X
1 1 1 1	XXX X

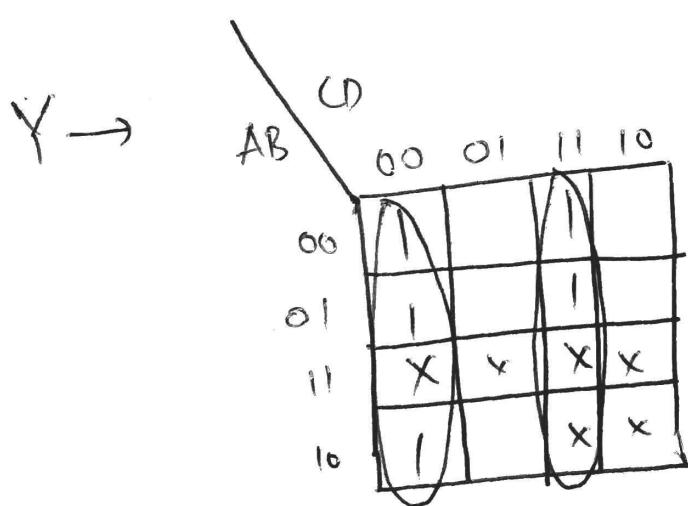
K Map for BCD to XS3



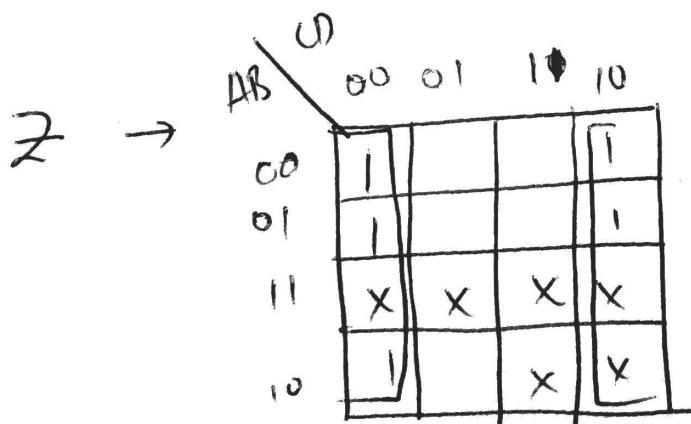
$$W = A + BC + BD$$



$$X = \overline{B}C + \overline{B}D + B\overline{C}\overline{D}$$



$$Y = CD + \overline{C}\overline{D}$$



$$Z = D$$

Using the Espresso algorithm for

getting min Row PLA

Expression / Term	A	B	C	D	W	X	Y	Z
$\bar{B}\bar{C}\bar{D}$	-	1	0	0	0	1	0	0
$\bar{B}C\bar{D}$	-	0	1	0	0	1	0	1
$\bar{B}D$	-	0	-	1	0	1	0	0
CD	-	-	1	1	0	0	1	0
$B\bar{C}\bar{D}$	-	1	1	0	1	0	0	1
BD	-	1	-	1	1	0	0	0
$\bar{C}\bar{D}$	-	-	0	0	0	0	1	1
A	1	-	-	-	1	0	0	0

Minimum PLA:

$$W = \underline{\bar{B}\bar{C}\bar{D}} + BD + A$$

$$X = \underline{\bar{B}\bar{C}\bar{D}} + \underline{\bar{B}C\bar{D}} + \underline{\bar{B}D}$$

$$Y = CD + \underline{\bar{C}\bar{D}}$$

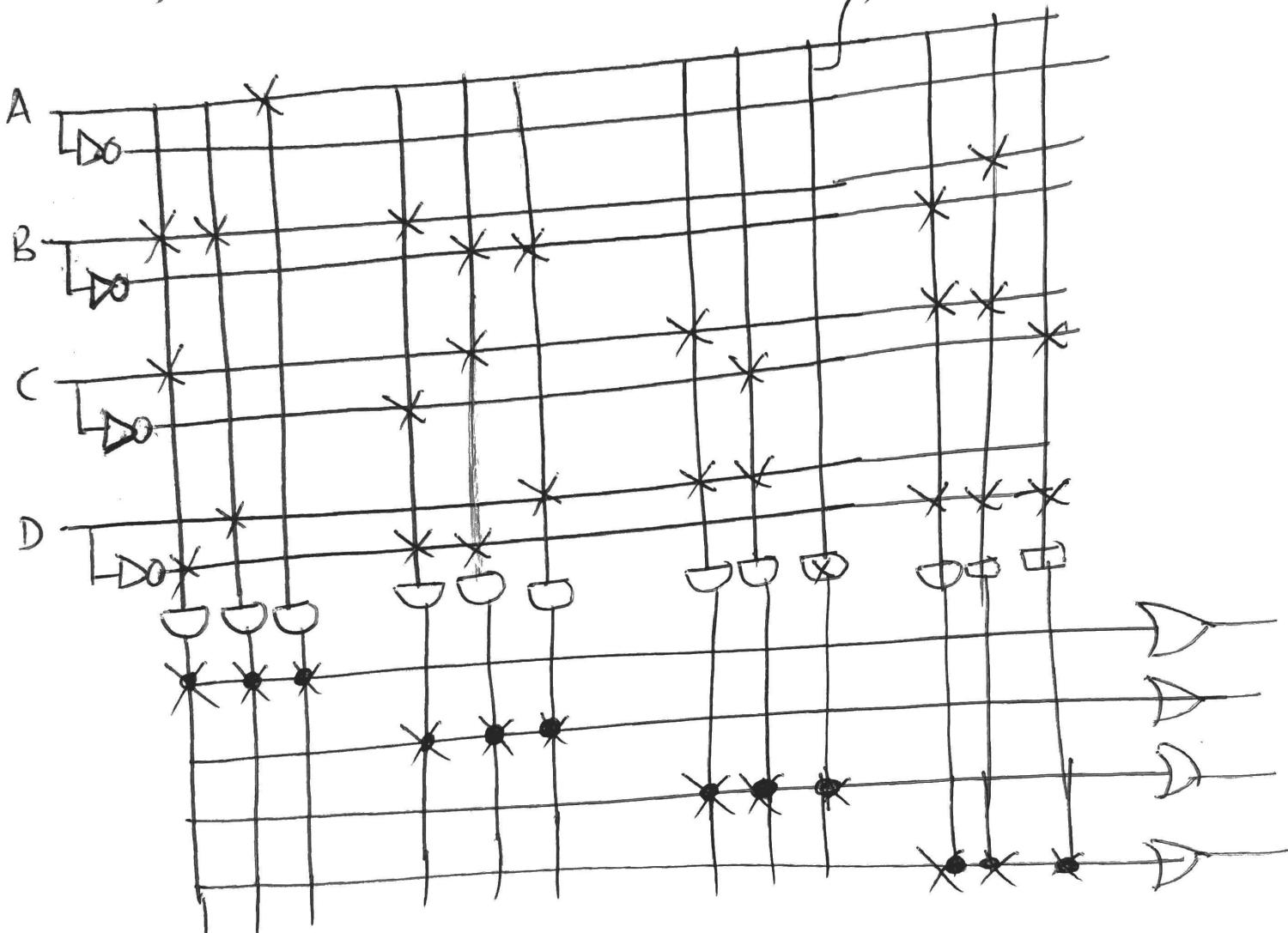
$$Z = \underline{\bar{B}C\bar{D}} + \underline{B\bar{C}\bar{D}}$$

$$+ \underline{\bar{C}\bar{D}}$$

PAL Logic Diagram (Take max # of

terms) → 3 AND Gates:

Line not Used



OR Gates Fixed

Not programmable

4) Truth Table:

Input			Output				
	X	Y	Z	A	B	C	D
0	0	0	0	0	1	0	0
1	0	0	1	1	1	1	1
2	0	1	0	1	0	1	1
3	0	1	1	0	1	0	1
4	1	0	0	1	1	1	0
5	1	0	1	0	0	0	1
6	1	1	0	1	0	1	0
7	1	1	1	0	1	1	1

Simplifying the Kmaps for each:

A \rightarrow	X	Y	Z	00	01	11	10
	0	0	0	0	1	0	1
	1	1	0	1	0	1	0

B \rightarrow	X	Y	Z	00	01	11	10
	0	0	0	0	1	1	2
	1	1	0	4	5	7	6

C \rightarrow	X	YZ	00	01	11	10
	0	0	0	1	0	1
	1	1	1	0	1	0

D \rightarrow	X	YZ	00	01	11	10
	0	0	0	1	1	2
	1	1	0	1	1	0

Simplified Expression using KMap for each o/p is:

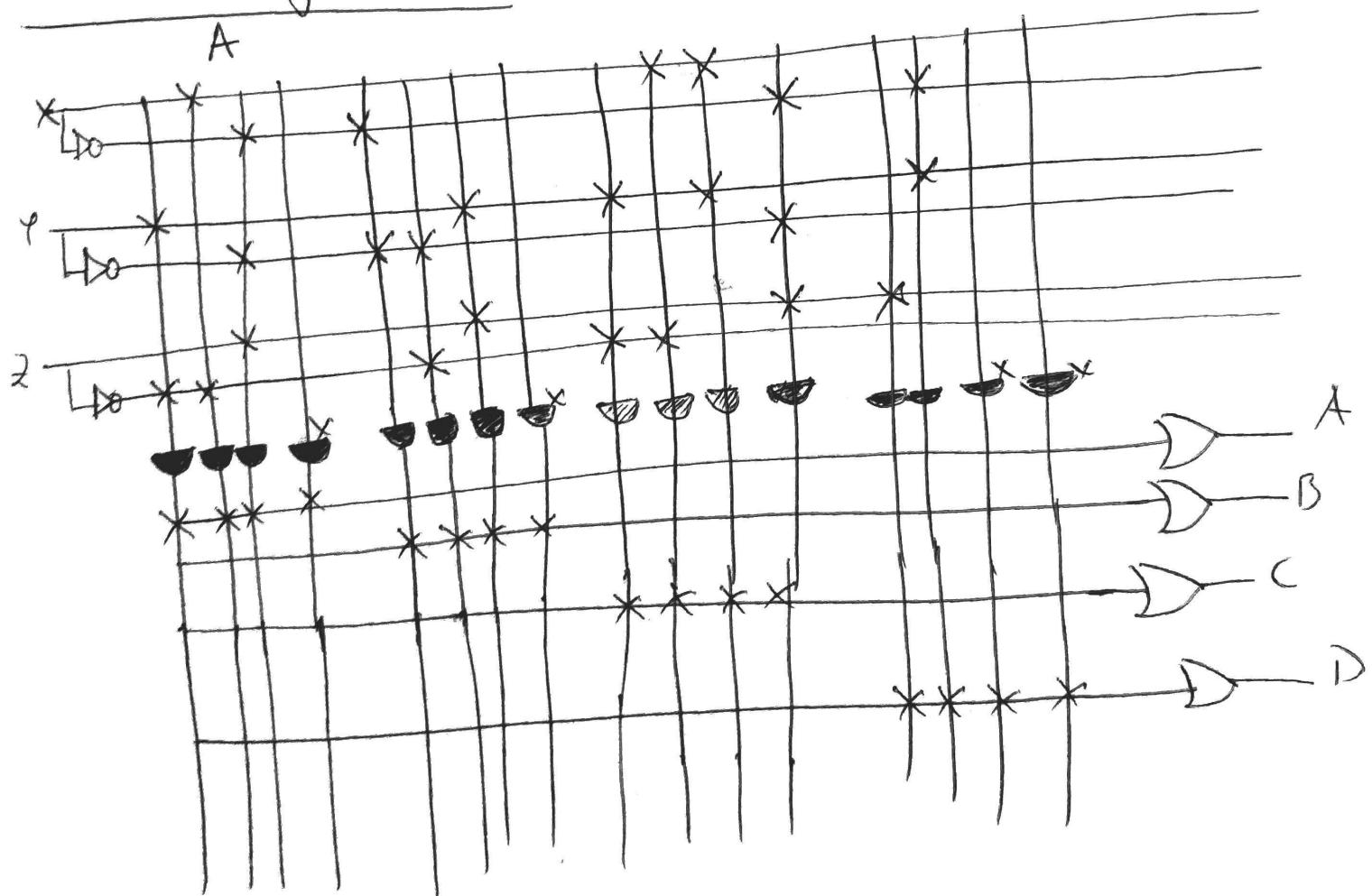
$$A = X\bar{Z} + \bar{X}\bar{Z} + \bar{X}\bar{Y}Z$$

$$B = \bar{X}\bar{Y} + \bar{Y}\bar{Z} + YZ$$

$$C = Y\bar{Z} + X\bar{Z} + XY + \bar{X}\bar{Y}Z \rightarrow \text{Max # of AND Gates}$$

$$D = Z + \bar{X}Y$$

PAL Diagram is:



5) Full Subtractor using PAL:

Input			Output	
A	B	Bin	D	Bout
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

Difference:

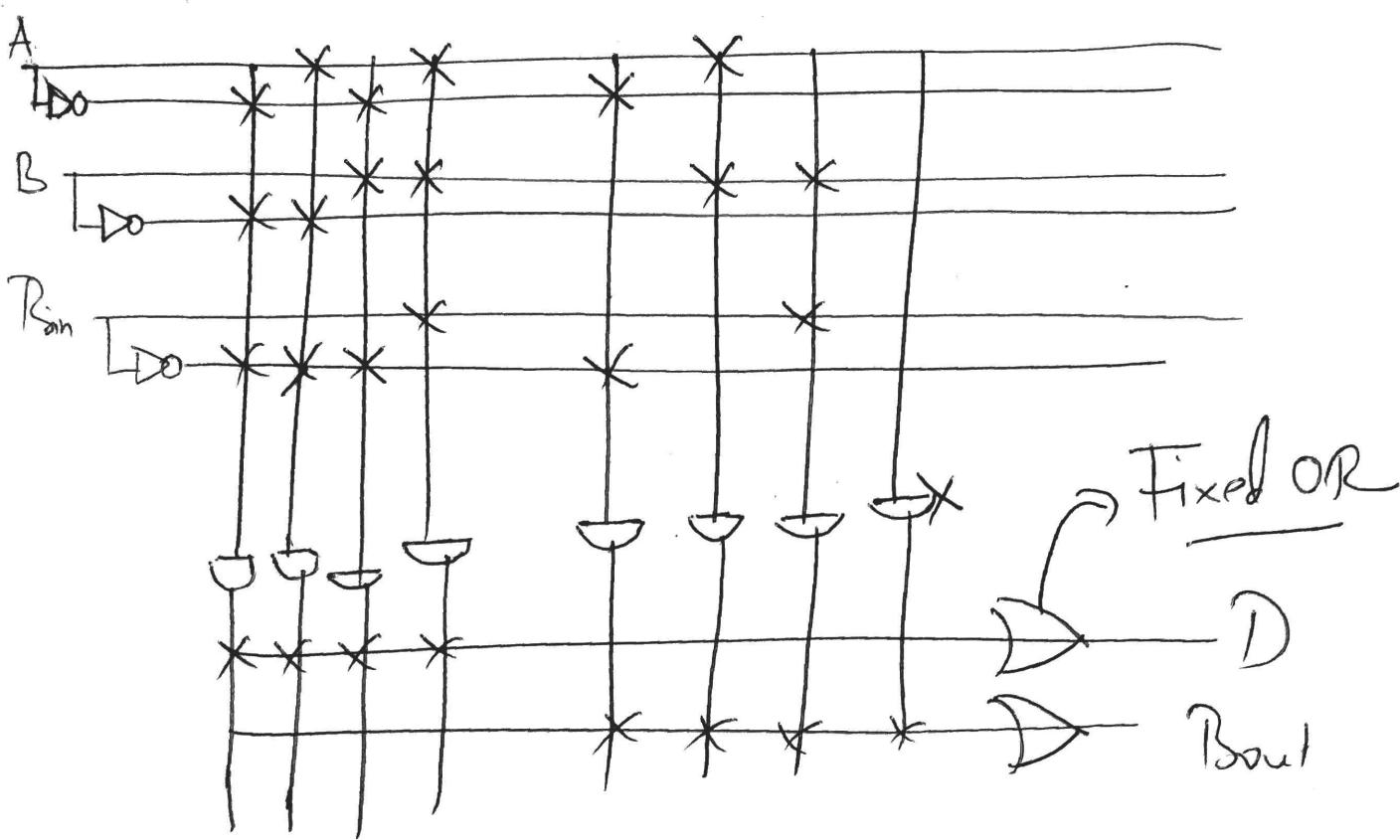
	Bbin			
A	00	01	11	10
0	00	01	10	11
1	10	11	00	01

	Bbin			
A	00	01	11	10
B	0	01	10	0
1	0	0	10	0

$$B_{out} = \bar{A}\bar{B}B_{in} + \bar{A}B\bar{B}_{in} + AB\bar{B}_{in}$$

$$D = \bar{A}\bar{B}B_{in} + A\bar{B}\bar{B}_{in} + \bar{A}B\bar{B}_{in} + AB\bar{B}_{in}$$

Implementation using ~~PLA~~: PAL:



Programmable AND , Fixed OR