2/1/19

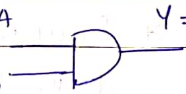
UNIT - I

* **Gate** : logic circuit ω multiple i/p but one o/p

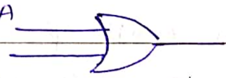
* **Basic gates** :

1) AND

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

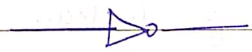
A
B

$Y = AB = A \cdot B$

2) OR

A
B

$Y = A + B$

3) NOT

Once compliment of given value

A

$Y = \bar{A}$ or A'

* **Boolean laws**

	Boolean laws	Duality Theorem
Commutative	1) $A + B = B + A$	$AB = BA$
Associative	2) $A + (B+C) = (A+B) + C$	$A(BC) = (AB)C$
Distributive	3) $A(B+C) = AB + AC$	$A + BC = (A+B)(A+C)$
	4) $A + 0 = A$	$A \cdot 1 = A$
	5) $A + 1 = 1$	$A \cdot 0 = 0$
	6) $A + A = A$	$A \cdot A = A$
	7) $A + \bar{A} = 1$	$A \cdot \bar{A} = 0$

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8) $\bar{\bar{A}} = A$

I De Morgan 9) $(\overline{A+B}) = \bar{A}.\bar{B}$ $\qquad \overline{AB} = \bar{A} + \bar{B}$

10) $A + AB = A$ $\qquad A(A+B) = A$

11) $A + \bar{A}B = A+B$ $\qquad A(\bar{A}+B) = AB$

12) $AB + A\bar{B} = A$ $\qquad (A+B)(A+\bar{B}) = A$

* <u>Duality Theorem</u>

States that starting w a boolean relation another boolean relationship can be obtained by 1) Changing each OR operator to an AND. OPERATOR

2) Changing each AND op. to OR op.

3) Complimenting any 0 or 1 in the expression

Q Simplify the following boolean functions by applying boolean laws

1) $A(\bar{A}+C)(\bar{A}B+C)(\bar{A}BC+\bar{C}) = 0$

$\longrightarrow (A\bar{A} + AC)(\bar{A}B\bar{A}BC + \bar{A}B\bar{C})(C\bar{A}BC + C\bar{C})$

$(0 + AC)(\bar{A}BC + \bar{A}B\bar{C})(\bar{A}BC + 0)$

$(AC\bar{A}BC + AC\bar{A}B\bar{C})(\bar{A}BC)$

$(0+0)(\bar{A}BC)$

$0(\bar{A}BC)$

0

In exam write the how that is used

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2) $A\bar{B} + AB + BC$

$A\,(\bar{B} + B) + BC$

$A + BC$

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

$C\,\underbrace{(\bar{A}B + A\bar{B})}_{\text{EXOR}} + AB$

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

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

$BC + AC + AB$

4) $ABC + \bar{A}B + B\bar{C}$

$B\,(AC + \bar{A} + \bar{C})$

5) $(\overline{A + B})\,(\overline{\bar{A} + \bar{B}})$

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

$\bar{A}.\bar{B}\,(AB)$

0

6) $\overline{A\bar{B}} + \overline{\bar{A}B} = (\bar{A} + \bar{\bar{B}})\,(\bar{\bar{A}} + \bar{B})$

$\bar{A}B + A\bar{B}$

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

$\bar{A}.A + \bar{A}\bar{B} + BA + \bar{B}B$

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

Q Prove that

1) $\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + \bar{A}BC + A\bar{B}\bar{C} = \bar{A}$

$\rightarrow \bar{A}\bar{B}\bar{C} + \bar{A}BC + \bar{A}\bar{B}\bar{C} + \bar{A}BC + \bar{A}\bar{B}\bar{C} +$

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

$\Rightarrow \bar{A}\bar{B}\bar{C} + \bar{A}\bar{C}(B + \bar{B}) + \bar{A}(BC + \bar{B}\bar{C})$

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

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

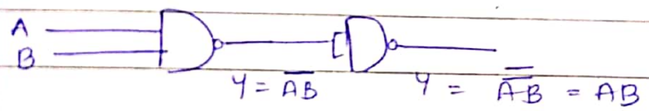
$\bar{A}(\bar{B}\bar{C} + \bar{C} + 1) + (\bar{B}\bar{C})$

$\bar{A}\ \{ C (\bar{B}$

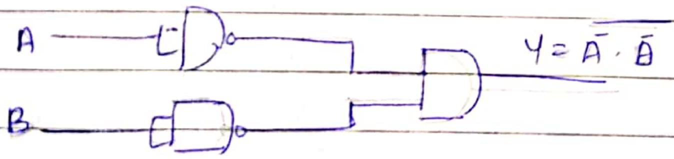
* Universal Gates

NAND, NOR

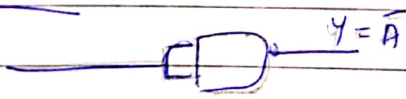
1) NAND as AND



2) NAND as OR

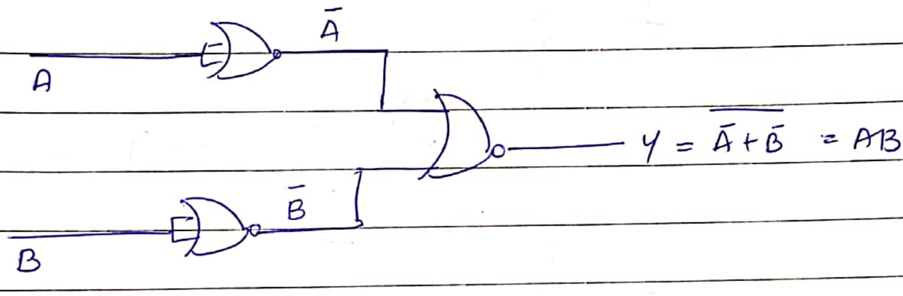


3) NAND as NOT

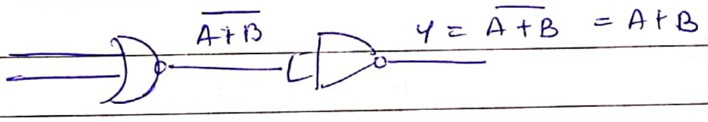


(1) NOR as AND

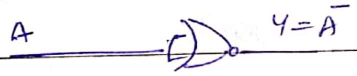
$$\overline{\bar{A} + \bar{B}} = \bar{\bar{A}} \cdot \bar{\bar{B}} = AB$$



(2) NOR as OR

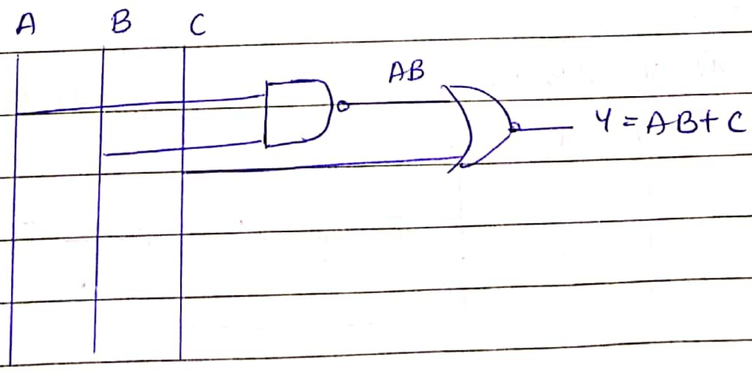


(3) NOR as NOT



Q Realize the given boolean expressions using basic gates.

1) $Y = AB + C$



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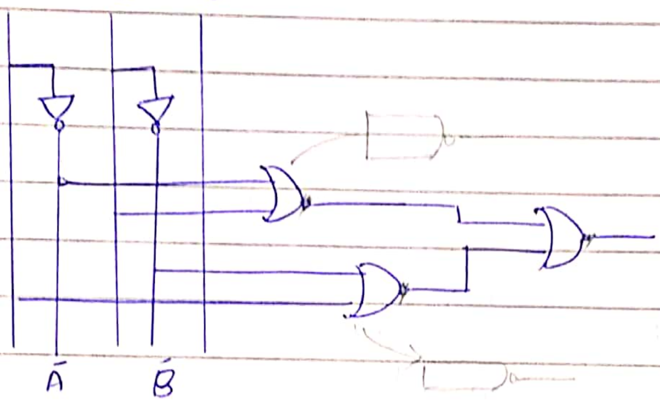
2) $F = \bar{A}+B + A+\bar{B}$ $\quad F = \bar{A}B + A\bar{B}$



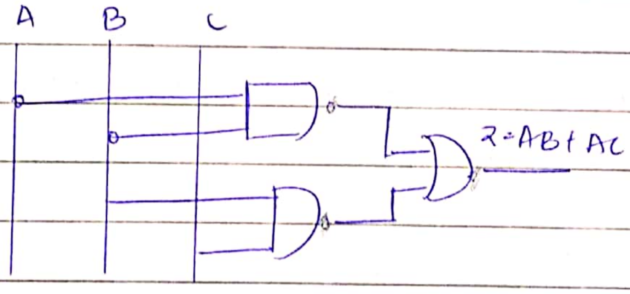
3) $Z = AB\bar{C} + A\bar{B}C + ABC$

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

$AB(C+\bar{C}) + AC(B+\bar{B}) + ABC$

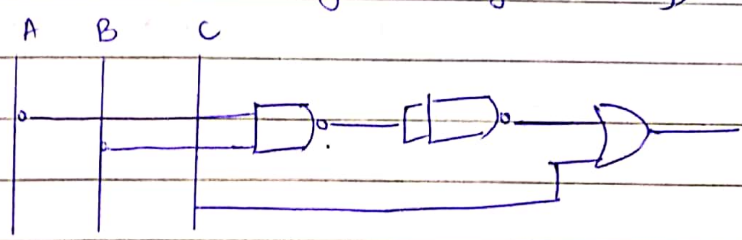
$AB + AC + \cancel{ABC}$

$A(B+C+\cancel{BC})$



4) $Y = AB + C$ (using NAND gates only)

wrong



Q)

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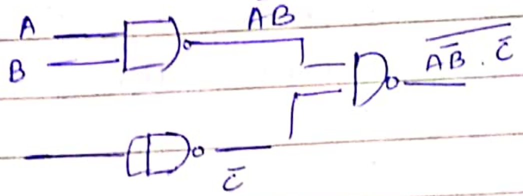
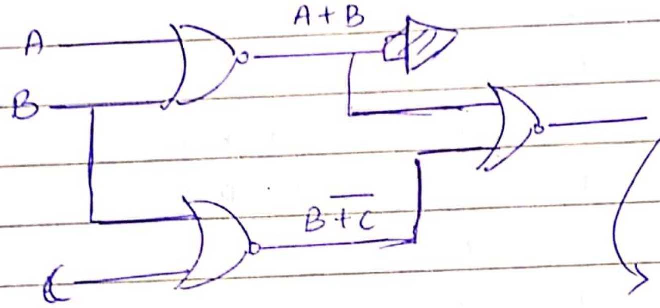


Q) Realize the given expression $(A+B)(B+C)$ using NOR gate



$\overline{(\overline{A+B}) + (\overline{B+C})}$

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

$(A+B)\ (B+C)$

$(\overline{\overline{A+B}}) \cdot (\overline{\overline{B+C}})$

* Sum of Product (SOP)

A	B	C	Y	
0	0	0	0	
0	0	1	1	$\bar{A}\bar{B}C$
0	1	0	1	$\bar{A}B\bar{C}$
0	1	1	1	$\bar{A}BC$
1	0	0	1	$A\bar{B}\bar{C}$
1	0	1	1	$A\bar{B}C$
1	1	0	1	$AB\bar{C}$
1	1	1	1	ABC

minterms

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

$= \Sigma m(1, 2, 3, 4, 5, 6, 7)$

$= \Sigma (m_1 + m_2 + m_3 + m_4 + m_5 + m_6 + m_7)$

Product term : The combination of all variables

Min term : " where the product gives high o/p.

Q Write the expression for the o/p Y given in the truth table

A	B	C	Y	
0	0	0	0	
0	0	1	1	$\bar{A}\bar{B}\bar{C}$
0	1	1	1	$\bar{A}BC$
1	0	0	0	
1	0	1	1	$\bar{A}\bar{B}C$
1	1	0	0	
1	1	1	0	

→ $Y = \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}C$

$= \Sigma m(1, 3, 5)$

Q Write down all the product terms for two variable boolean function

→

A	B	Y		
0	0	$\cancel{0}$	$\bar{A}\bar{B}$ m_0	product terms
0	1	$\cancel{1}$	$\bar{A}B$ m_1	
1	0	$\cancel{1}$	$A\bar{B}$ m_2	
1	1	$\cancel{1}$	AB m_3	

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Q. Convert the given expression in standard SOP

1. $AC + AB + BC$

$\rightarrow$ $AC(B+\bar{B}) + AB(C+\bar{C}) + BC(A+\bar{A})$

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

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

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

$\rightarrow$ $= \bar{A}B(C+\bar{C}) + BC(A+\bar{A})$

$= \bar{A}BC + \bar{A}B\bar{C} + BCA + BC\bar{A}$

$= \bar{A}BC + \bar{A}B\bar{C} + BCA$

Q* <u>K-Map</u> <u>Reduction</u> <u>Technique</u>

2 variable

A \ B	0	1
0	$\bar{A}\bar{B}$ m_0	$\bar{A}B$ m_1
1	$A\bar{B}$ m_2	AB m_3

3 variable

A \ BC	00	01	11	10
0	$\bar{A}\bar{B}\bar{C}$ m0	$\bar{A}\bar{B}C$ m1	$\bar{A}BC$ m3	$\bar{A}B\bar{C}$ m2
1	$A\bar{B}\bar{C}$ m4	$A\bar{B}C$ m5	ABC m7	$AB\bar{C}$ m6

4 variable

AB \ CD	00	01	11	10
00	$\bar{A}\bar{B}\bar{C}\bar{D}$ m0	$\bar{A}\bar{B}\bar{C}D$ m1	$\bar{A}\bar{B}CD$ m3	$\bar{A}\bar{B}C\bar{D}$ m2
01	$\bar{A}B\bar{C}\bar{D}$ m4	$\bar{A}B\bar{C}D$ m5	$\bar{A}BCD$ m7	$\bar{A}BC\bar{D}$ m6
11	$AB\bar{C}\bar{D}$ m12	$AB\bar{C}D$ m13	$ABCD$ m15	$ABC\bar{D}$ m14
10	$A\bar{B}\bar{C}\bar{D}$ m8	$A\bar{B}\bar{C}D$ m9	$A\bar{B}CD$ m11	$A\bar{B}C\bar{D}$ m10

Q Plot the value in the K Map for the truth given below

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

A \ B	0	1
0	0	1
1	1	0

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2)

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

A \ BC	00	01	11	10
0	0 m_0	1 m_1	0 m_3	0 m_2
1	1 m_4	0 m_5	0 m_7	1 m_6

3)

A	B	C	D	Y
0	0	0	0	0
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	ϕ	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	ϕ	0	0
ϕ	1	1	1	1

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AB \ CD	00	01	11	10
00	0 m_0	1 m_1	0 m_3	0 m_2
01	0 m_4	1 m_5	0 7	1 6
11	1 12	0 13	1 15	0 14
10	1 8	1 9	0 10	0 11

Q Represent the given std SOP function on KMap.

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

$= \Sigma m(3, 6, 7)$

A \ BC	00	001	11	10
0	0 m_0	0 m_1	1 m_3	0 m_2
1	m_4	0 m_5	1 m_7	1 m_6

Q Plot the KMap for the given boolean function

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

$\bar{A}BC + \bar{A}B\bar{C} + ACB + AC\bar{B}$

$\Sigma m(3, 2, 7, 5)$

A \ BC	00	01	11	10
0	0 m_0	0 m_1	1 m_3	1 m_2
1	0 m_4	1 m_5	1 m_7	0 m_6

_/_/_

* Grouping Cells for Simplification

1) Grouping two adjacent one (pair) (eliminates one variable)

(i) Horizontally adjacent ones

Take common

A \ BC	00	01	11	10
0	0	1	1	0
1	0	0	0	0

$Y = \bar{A}C$

(ii) Vertically

A \ BC	00	01	11	10
0	0	1	0	0
1	0	1	0	0

$Y = \bar{B}C$

(iii) A \ BC

0	0	0	0
1	0	0	1

$Y = A\bar{C}$

(iv)

AB \ CD	00	01	11	10
00	0	1	0	0
01	0	0	0	0
11	0	0	0	0
10	0	1	0	0

$Y = \bar{B}\bar{C}D$

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2) Two overlapping pairs

①

A \ BC	00	01	11	10
0	0	1	1	0
1	0	0	1	0

$Y = \bar{A}C + BC$

②

A \ BC	00	01	11	10
0	0	1	1	0
1	0	0	1	1

$Y = \bar{A}C + AB$

③

A \ BC	00	01	11	10
0	0	0	0	1
1	1	0	0	1

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

3) Group of four ones (Quad) : eliminates two variables

(i)

A \ B	0	1
0	1	1
1	1	1

$Y = 1$

(ii)

A \ BC	00	01	11	10
0	0	0	0	0
1	1	1	1	1

$Y = A$

AB \ CD	00	01	11	10
00			1	
01			1	
11			1	
10			1	

$Y = CD$

||ly horizontal

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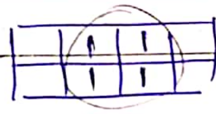
(v)

AB \ CD	00	01	11	10
00	1	0	0	1
1	1	0	0	1

$Y = \bar{C}$

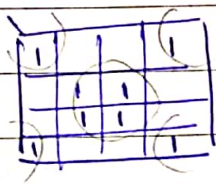
(vi) corners for quad

$Y = \bar{B}\bar{D}$



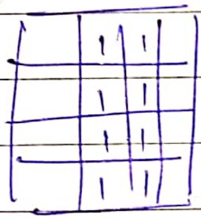
+ in centre

$Y = \bar{B}\bar{D} + BD$

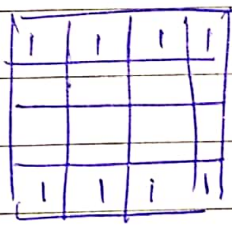


3) Group of eight ones (octet) : eliminates three variables.

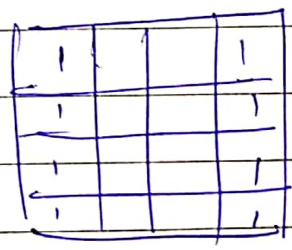
① $Y = D$ ① $Y = D$ ② $Y = \bar{B}$ ③ $Y = B$ ④ $Y = \bar{D}$



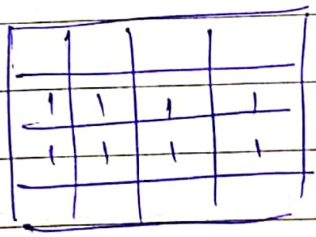
② $Y = \bar{B}$



④ $Y = \bar{D}$



③



$Y = B$

Q Simplify the given boolean expression using K-map reduction technique.

000	m_0
001	m_1
010	m_2
011	m_3
100	m_4
101	m_5
110	m_6
111	m_7

1. $Y = A\bar{B}C + \bar{A}\bar{B}C + \bar{A}BC + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C}$

$101 + 001 + 011 + 100 + 000$

$\Sigma m(5, 1, 3, 4, 0)$

A \ BC	00	01	11	10
0	1 (0)	1 (1)	1 (3)	0 (2)
1	1 (4)	1 (5)	0 (7)	0 (6)

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

2. $Y = Y(A, B, C) = \bar{A}B + \bar{B}C + AB$

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

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

$\rightarrow 011 + 010 + 101 + 001 + 111 + 110$

$\rightarrow \Sigma m(3, 2, 5, 1, 7, 6)$

A \ BC	00	01	11	10
0	(0)	1 (1)	1 (3)	1 (2)
1	(4)	1 (5)	1 (7)	1 (6)

$Y = C + B$

Q Plot K-map for the given truth table & obtain the reduced ~~K-map~~ boolean expression

①

A	B	C	Y	
0	0	0	1	m_0
0	0	1	0	m_1
0	1	0	0	m_2
0	1	1	1	m_3
1	0	0	1	m_4
1	0	1	0	m_5
1	1	0	0	m_6
1	1	1	1	m_7

A \ BC	00	01	11	10
0	1_0	0_1	1_3	0_2
1	1_4	0_5	1_7	0_6

$Y = \bar{B}\bar{C} + BC$

② $Y = \bar{A}\bar{B}CD + ABC\bar{D} + A\bar{B}C\bar{D} + A\bar{B}CD + A\bar{B}\bar{C}\bar{D} + AB\bar{C}\bar{D} + \bar{A}\bar{B}CD + \bar{A}\bar{B}\bar{C}\bar{D}$

→ 0011 + 1110 + ~~010~~1010 + 1011 + 1000 + 1100 + 0011 + 0000

→ $\Sigma m(2, 14, 10, 11, 8, 12, 3, 0)$

AB \ CD	00	01	11	10
00	1_0	1	1_3	1_2
01	4	5	7	6
11	1_{12}	13	15	1_{14}
10	1_8	9	1_{11}	1_{10}

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

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3) $Y = \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + AB\bar{C}\bar{D} + AB\bar{C}D + A\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D}$

$\Sigma m\,(2, 4, 5, 9, 12, 13)$

AB \ CD	00	01	11	10
00	0	0_{1}	3	1_{2}
01	1_{4}	1_{5}	7	6
11	1_{12}	1_{13}	15	14
10	8	1_{9}	11	10

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

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

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

$= \Sigma m\,(1, 5, 8, 2, 10, 6)$

AB \ CD	00	01	11	10
00	0	1_{1}	3	1_{2}
01	4	1_{5}	7	1_{6}
11	12	13	15	14
10	1_{8}	9	11	1_{10}

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

5>

000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

6>

_/_/_

_/_

$+\bar A\bar B C\bar D$

000 0
001 1
010 2
011 3
100 4
101 5
110 6
111 7

$C\bar D$

5> $\bar A\bar B C + \bar A\bar B\bar C + A\bar B\bar C + A\bar B C + \bar A B C$

001 + 000 + 100 + 101 + 011

$m_1 + m_0 + m_4 + m_5 + m_3$

A \ BC	00	01	11	10
0	1_0	1_1	1_3	$_2$
1	1_4	1_5	$_7$	$_6$

$Y = \bar B + \bar A C$

6> $Y = \bar B\bar C\bar D + \bar A B\bar C\bar D + AB\bar C\bar D + \bar A\bar B CD + A\bar B CD +$
$\bar A\bar B C\bar D + ABC\bar D + \bar A BC\bar D + A\bar B C\bar D$

$= A\bar B\bar C\bar D + \bar A\bar B\bar C\bar D + \bar A B\bar C\bar D + AB\bar C\bar D + \bar A\bar B CD + A\bar B CD$
$+ \bar A\bar B C\bar D + ABC\bar D + \bar A BC\bar D + A\bar B C\bar D$

$= 1000 + 0000 + 0100 + 1100 + 0011 + 1011$
$+ 0010 + 1110 + 0110 + 1010$

$= \Sigma m(8, 0, 4, 12, 3, 11, 2, 14, 6, 10)$

AB \ CD	00	01	11	10
00	1_0	$_1$	1_3	1_2
01	1_4	$_5$	$_7$	1_6
11	1_{12}	$_{13}$	$_{15}$	1_{14}
10	1_8	$_9$	1_{11}	1_{10}

$Y = \bar D + \bar C\bar B$

Scanned by CamScanner

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⇒ **Don't care condition**

Q Plot the k-map for the given truth table & obtain the reduced boolean expression

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	X
1	1	1	X

A \ BC	00	01	11	10
0		1	1	0
1		1	X	X

$Y = C$

Q Find the reduced SOP for the given boolean expression

$F(A, B, C, D) = \Sigma m\,(1, 3, 7, 11, 15) + \Sigma d\,(0, 2, 4)$

AB \ CD	00	01	11	10
00	X	1	1	X
01	X		1	
11			1	
10			1	

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

_/_/_

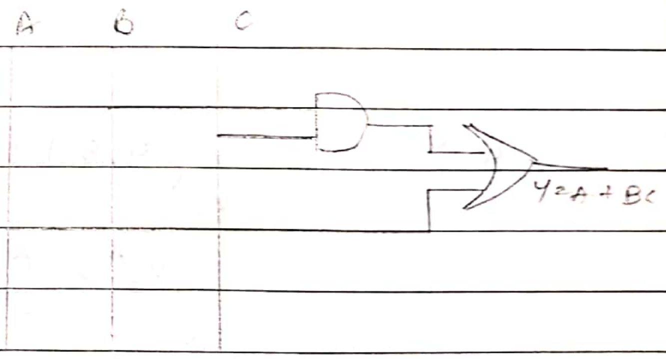
0-5 ⇒ 0 6-9 ⇒ 1

Q The input to a combinational logic circuit is a valid single digit BCD data. Design the logic circuit using minimum Hardware to detect whenever a number greater than 5 appears at the input.

	A B C D	Y
0	0 0 0 0	0
1	0 0 0 1	0
2	0 0 1 0	0
3	0 0 1 1	0
4	0 1 0 0	0
5	0 1 0 1	0
6	0 1 1 0	1
7	0 1 1 1	1
8	1 0 0 0	1
9	1 0 0 1	1
10	1 0 1 0	x
11	1 0 1 1	x
12	1 1 0 0	x
13	1 1 0 1	x
14	1110 ~~1101~~	x
15	1 1 1 1	x

AB \ CD	00	01	11	10
00	0	1	3	2
01	4	5	1 7	1 6
11	X 12	X 13	X 15	X 14
10	1 8	1 9	X 11	X 10

$Y = A + BC$



__/__/__

⇒ Product of Sum

	Maxterms	A B C	Minterms	
M_0	$A+B+C$	0 0 0	$\bar{A}\bar{B}\bar{C}$	m_0
M_1	$A+B+\bar{C}$	0 0 1	$\bar{A}\bar{B}C$	m_1
M_2	$A+\bar{B}+C$	0 1 0	$\bar{A}B\bar{C}$	m_2
M_3	$A+\bar{B}+\bar{C}$	0 1 1	$\bar{A}BC$	m_3
M_4	$\bar{A}+B+C$	1 0 0	$A\bar{B}\bar{C}$	m_4
M_5	$\bar{A}+B+\bar{C}$	1 0 1	$A\bar{B}C$	m_5
M_6	$\bar{A}+\bar{B}+C$	1 1 0	$AB\bar{C}$	m_6
M_7	$\bar{A}+\bar{B}+\bar{C}$	1 1 1	ABC	m_7

q. $Y = \pi M(0,1,2,3,4,5,7)$

A \ BC	00	01	11	10
0	0	0	0	0
1	0	0	0	1

$Y = A \times (B) \times \bar{C}$

q. $Y = \pi M(0,1,2,4,5) + \pi d(8,9,11,12,13,15)$

AB \ CD	00	01	11	10
00	0 (0)	0 (1)	(3)	0 (2)
01	0 (4)	0 (5)	(7)	(6)
11	X (12)	X (13)	X (15)	(14)
10	X (8)	X (9)	(11)	(10)

$Y = C \cdot (A+B+D)$

→ Quine McCluskey Reduction Technique

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

0000, 0001, 0011, 0111, 1000, 1001, 1011, 1111.

Step 0

Group	Minterms	Variables (A B C D)	
0	0	0 0 0 0	✓
1	1	0 0 0 1	✓
	8	1 0 0 0	✓
2	3	0 0 1 1	✓
	9	1 0 0 1	✓
3	7	0 1 1 1	✓
	11	1 0 1 1	✓
4	15	1 1 1 1	✓

Step 1

Group	Minterms	Variables (A B C D)	
0	(0,1)	0 0 0 -	✓
	(0,8)	- 0 0 0	✓
1	(1,3)	0 0 - 1	✓
	(1,9)	- 0 0 1	✓
	(8,9)	1 0 0 -	✓
2	(3,7)	0 - 1 1	✓
	(3,11)	- 0 1 1	✓
	(9,11)	1 0 - 1	✓
3	(7,15)	- 1 1 1	✓
	(11,15)	1 - 1 1	✓

Minterms
m0
m1
m2
m3
m4
m5
m6
m7

,15)

⇒ **Quine Mcclusky Reduction Technique**

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

0000, 0001, 0011, 0111, 1000, 1001,
1011, 1111

Step 0

Group	Minterms	Variables A B C D	
0	0	0 0 0 0	✓
1	1	0 0 0 1	✓
	8	1 0 0 0	✓
2	3	0 0 1 1	✓
	9	1 0 0 1	✓
3	7	0 1 1 1	✓
	11	1 0 1 1	✓
4	15	1 1 1 1	✓

Step 1

Group	Minterms	Variables A B C D	
0	(0,1)	0 0 0 -	✓
	(0,8)	- 0 0 0	✓
1	(1,3)	0 0 - 1	✓
	(1,9)	- 0 0 1	✓
	(8,9)	1 0 0 -	✓
2	(3,7)	0 - 1 1	✓
	(3,11)	- 0 1 1	✓
	(9,11)	1 0 - 1	✓
3	(7,15)	- 1 1 1	✓
	(11,15)	1 - 1 1	✓

Step 2

Group	Minterms	Variables A B C D	
0	(0,1,8,9)	- 0 0 -	$\bar{B}\bar{C}$
	(0,8,1,9)	- 0 0 -	
1	(1,3,9,11)	- 0 - 1	$\bar{B}D$
	(1,9,3,11)	- 0 - 1	
2	(3,7,11,15)	- - 1 1	CD
	(3,11,7,15)	- - 1 1	

Prime Implicants Chart

PI terms	Groups	0	1	3	7	8	9	11	15
$\bar{B}\bar{C}$ ←	0, 1, 8, 9 ←	×	×			×	×		
$\bar{B}D$	1, 3, 9, 11		×	×			×	×	
CD ←	3, 7, 11, 15 ←			×	×		×		×

$Y = \bar{B}\bar{C} + CD$ are essential prime implicants

Q Minimize the given boolean exp
$F(A,B,C,D) = \Sigma m(0,1,2,3,5,7,8,9,11,14)$

0000, 0001, 0010, 0011, 0101, 0111, 1000, 1001,
1011, ~~1101~~ 1110

STEP 0

Group	Minterm	Variables A B C D	
0	0	0 0 0 0	✓
1	1	0 0 0 1	✓
	2	0 0 1 0	✓
	8	1 0 0 0	✓

Group 2 3 STEP 1 Group 0 1 2

__/__/__

Group	Minterm	A	B	C	D	
2	3	0	0	1	1	✓
	5	0	1	0	1	✓
	9	1	0	0	1	✓
3	7	0	1	1	1	✓
	11	1	0	1	1	✓
	14	1	1	1	0	

STEP 1

Group	Minterms	A	B	C	D
0	(0,1)	0	0	0	-
	(0,2)	0	0	-	0
	(0,8)	-	0	0	0
1	(1,3)	0	0	-	1
	(1,5)	0	-	0	1
	(1,9)	-	0	0	1
	(2,3)	0	0	1	-
	(8,9)	1	0	0	-
2	(3,7)	0	-	1	1
	(3,11)	-	0	1	1
	(5,7)	0	1	-	1
	(9,11)	1	0	-	1

__/__/__

STEP2

Group	Minterms	Variables A B C D	
0	0,1,2,3	0 0 - -	$\bar{A}\bar{B}$
	0,2,1,3	0 0 - -	
	0,1,8,9	- 0 0 -	$\bar{B}\bar{C}$
	0,8,1,9	- 0 0 -	
1	1,3,5,7	0 - - 1	$\bar{A}D$
	1,5,3,7	0 - - 1	
	1,9,3,11	- 0 - 1	$\bar{B}D$
	1,3,9,11	~~0~~ 0 - 1	

Prime Implicants Chart

Minterms

PI terms	Groups	0	1	2	3	5	7	8
$\bar{A}\bar{B}$	0,1,2,3	x	x	x	x			
$\bar{B}\bar{C}$	0,1,8,9	x	x					x
$\bar{A}D$	1,3,5,7	x			x	x	x	
$\bar{B}D$	1,3,9,11	x			x			
$ABC\bar{D}$								

9	11	14
~~x~~		
x		
x	x	~~x~~
		x

Q. 4 (A,B,C,D) = Σm

STEP0 Group

0

1

2

3

4

STEP1 Group

0

1

2

3

Q. $Y(A,B,C,D) = \Sigma m(1,3,7,11,15) + \Sigma d(0,2,5)$

0001, 0011, 0111, 1011, 1111, 0000*, 0010*, 0101*

STEP 0 Group	Minterms	Variables ABCD	
0	0*	0000	✓
1	1	0001	✓
	2*	0010	✓
2	3	0011	✓
	5*	0101	✓
3	7	0111	✓
	11	1011	✓
4	15	1111	✓

STEP 1 Group	Minterm	Variables A B C D	
0	0*, 1	0 0 0 -	✓
	0*, 2	0 0 - 0	
1	1, 3	0 0 - 1	✓
	1, 5*	0 - 0 1	✓
	2*, 3	0 0 1 -	✓
2	3, 7	0 - 1 1	✓
	3, 11	- 0 1 1	✓
	5*, 7	0 1 - 1	✓
3	7, 15	- 1 1 1	✓
	11, 15	1 - 1 1	✓

{(0*, 1) & (0*, 2) Both are don't care}

__/__/__

STEP 2

Group	Minterms	Variables A B C D	
0	0*, 1, 2*, 3	0 0 - -	$\bar{A}\bar{B}$
	0*, 2*, 1, 3	0 0 - -	
1	1, 3, 5*, 7	0 - - 1	$\bar{A}D$
	1, 5*, 3, 7	0 - - 1	
2	3, 7, 11, 15	- - 1 1	CD
	3, 11, 7, 15	- - 1 1	

~~Y ≠ ĀB̄/≠ ĀD ≠CD~~

Prime Implicants Chart (Ignore "DON'T CARE")

PI Terms	Groups	0	1	2	3	7	11	15
$\bar{A}\bar{B}$	1, 3		x		x			
$\bar{A}D$	1, 3, 7		x		x	x		
CD	← 3, 7, 11, 15 ←				x	x	x	x

(Variables)

$Y = CD + \bar{A}D$ because 1, 3, 7 are covered making the exp complete

Q. $Y(A,B,C,D) = \sum m(5,7,3,15)$

0101, 0111, 0011, 1111

STEP 0

Group	Minterms	A B C D	
~~2~~ 1	5	0 1 0 1	✓
	3	0 0 1 1	✓
~~3~~ 2	7	0 1 1 1	✓
~~4~~ 3	15	1 1 1 1	

STEP 1 Group

1

2

STEP 2 Group

Prime Implicants

PI terms

$\bar{A}BD$

$\bar{A}CD$

BCD

] $\bar{A}\bar{B}$

] $\bar{A}D$

] CD

overed
omplete

__/__/__

STEP 1

Group	Minterms	A B C D	
1	5, 7	0 1 - 1	$\bar{A}BD$
	3, 7	0 - 1 1	$\bar{A}CD$
2	7, 15	- 1 1 1	BCD

STEP 2

Group	Minterms	A B C D

Prime Implicants Chart

PI terms	Groups	5	7	3	15
$\bar{A}BD$	5, 7	×	×		
$\bar{A}CD$	3, 7		×	×	
BCD	7, 15		×		×

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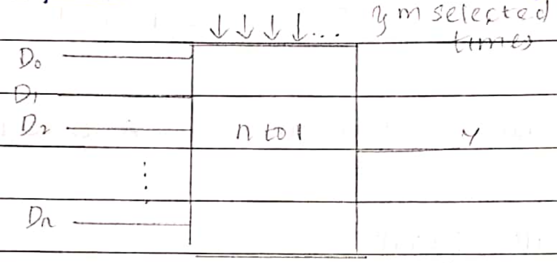
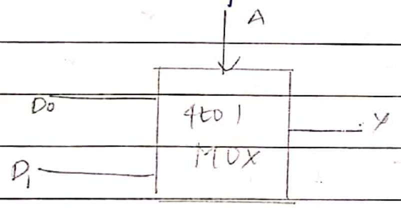
UNIT II

Data Processing Circuits

⇒* **Multiplexer** : Data PC in many i/p one o/p

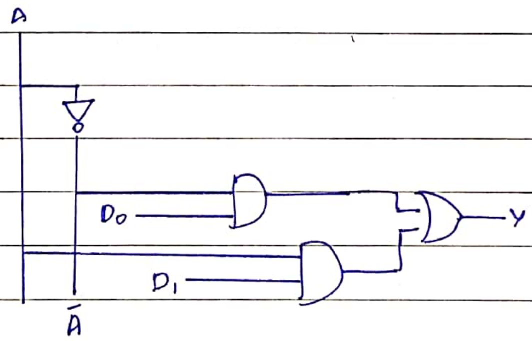


* 2 to 1 multiplexer

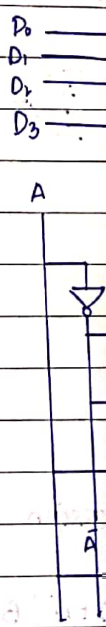


A	Y
0	D_0
1	D_1

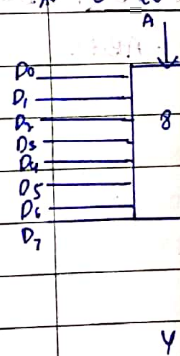
$$Y = \bar{A} D_0 + A.D_1$$



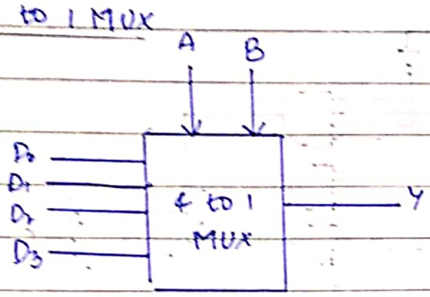
* 4 to 1 M



* 8 to

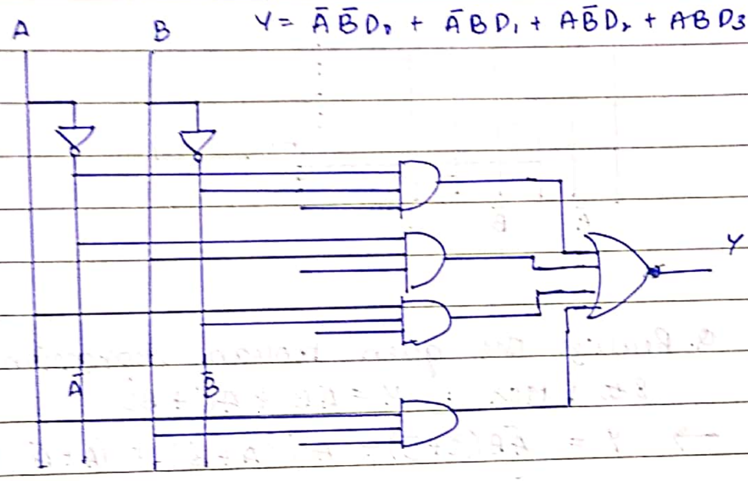


* 4 to 1 MUX

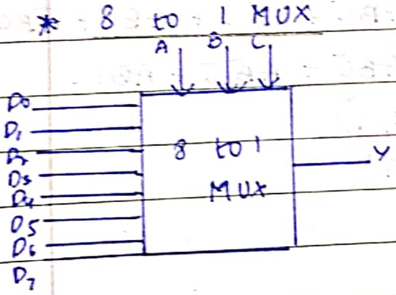


A	B	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

$Y = \bar{A}\bar{B}D_0 + \bar{A}BD_1 + A\bar{B}D_2 + ABD_3$



* 8 to 1 MUX



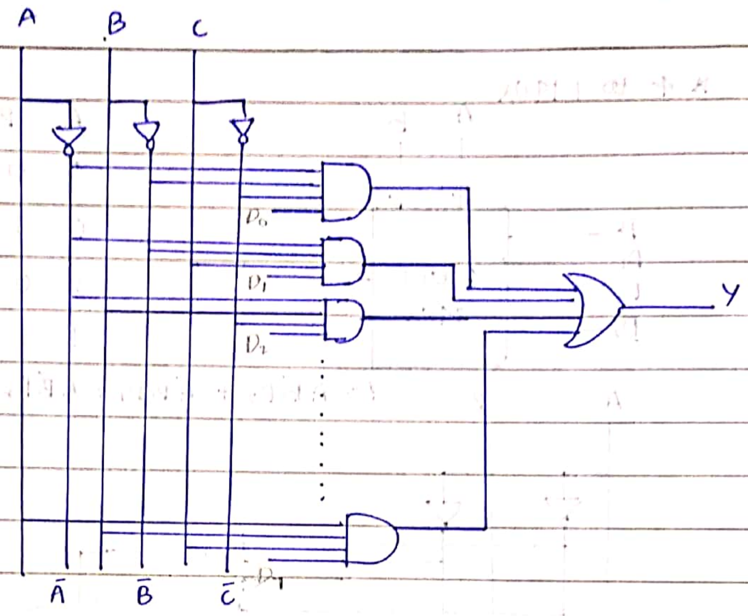
A	B	C	Y
0	0	0	D_0
0	0	1	D_1
0	1	0	D_2
0	1	1	D_3
1	0	0	D_4
1	0	1	D_5
1	1	0	D_6
1	1	1	D_7

$Y = \bar{A}\bar{B}\bar{C}D_0 + \bar{A}\bar{B}CD_1 + \bar{A}B\bar{C}D_2 + \bar{A}BCD_3 + A\bar{B}\bar{C}D_4 + A\bar{B}CD_5$

$\ldots + ABCD_7$

__/__/__

000 ✓	
001 ✓	
010 ✓	
011 ✓	
100	
101	
110	
111	



Q. Realize the given boolean expression using 8 to 1 MUX : $Y = \bar{A}B + A\bar{C} + BC$

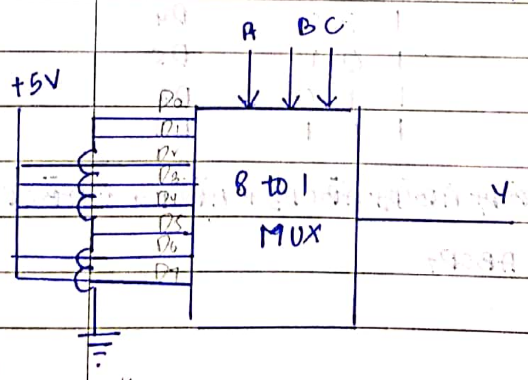
→ $Y = \bar{A}B(C+\bar{C}) + A\bar{C}(B+\bar{B}) + (A+\bar{A})BC$

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

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

$= \Sigma m(3, 2, 6, 4, 7)$

$= \Sigma m(2, 3, 4, 6, 7)$



Q) Using
Realiz
→ Y =
=
Σm
+5V

Q) Real
Y = (
and

__/__/__

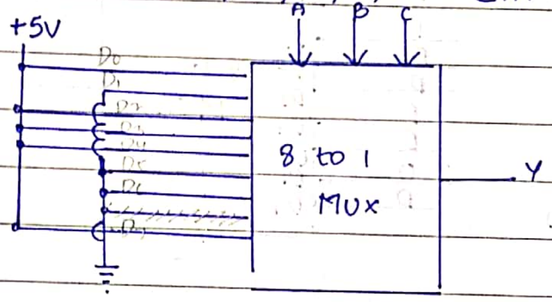
Q) Using 8 to 1 MUX solve $Y = \bar{A}B + \bar{B}\bar{C} + ABC$.
Realize it using 4 to 1 MUX

→ $Y = \bar{A}B(C+\bar{C}) + \bar{B}\bar{C}(A+\bar{A}) + ABC$

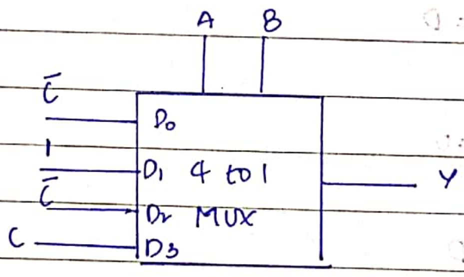
$= \bar{A}BC + \bar{A}B\bar{C} + A\bar{B}\bar{C} + \bar{A}\bar{B}\bar{C} + ABC$

$011 + 010 + 100 + 000 + 111$

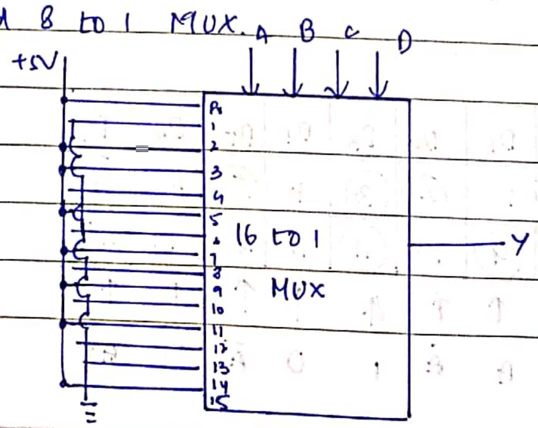
$\Sigma m(3, 2, 4, 0, 7) = \Sigma m(0, 2, 3, 4, 7)$



A	B	C	Y	
0	0	0	1	$Y = \bar{C}$
0	0	1	0	
0	1	0	1	$Y = 1$
0	1	1	1	
1	0	0	1	$Y = \bar{C}$
1	0	1	0	
1	1	0	0	$Y = C$
1	1	1	1	



Q) Realize the given boolean function
$Y = (A, B, C, D) = \Sigma m(0, 2, 3, 5, 7, 9, 11, 15)$. 16 to 1 MUX
and 8 to 1 MUX.



Nikita

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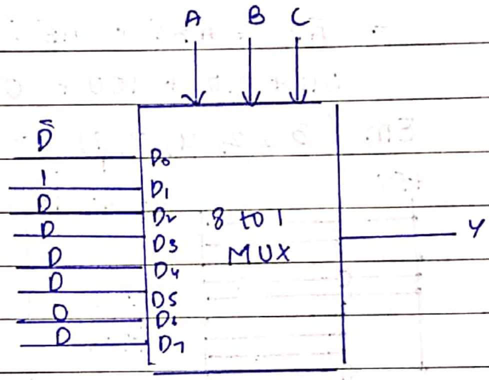
A	B	C	D	Y	
0	0	0	0	1	$Y = \bar{D}$
0	0	0	1	0	
0	0	1	0	1	$Y = 1$
0	0	1	1	1	
0	1	0	0	0	$Y = D$
0	1	0	1	1	
0	1	1	0	0	$Y = D$
0	1	1	1	1	
1	0	0	0	0	$Y = D$
1	0	0	1	1	
1	0	1	0	0	$Y = D$
1	0	1	1	1	
1	1	0	0	0	$Y = 0$
1	1	0	1	0	
1	1	1	0	0	$Y = D$
1	1	1	1	1	



Above same problem, use select line A as mapped entered variable

	D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7
$\bar{A}$	0	1	2	3	4	5	6	7
A	8	9	10	11	12	13	14	15
	$\bar{A}$	A	$\bar{A}$	1	0	$\bar{A}$	0	~~A~~ 1

01 08

Maths - This we...

Web - This we...

(N) Java - This ne...

Q) Implement The ...

$F(A,B,C) = \Sigma m($...

Use A as Map...

A	B	C
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

(ii) A a...

Imp...

01 08 | (M) Test. Web
Maths - This week | Java & Web
Web - this week
(M) Java - This week

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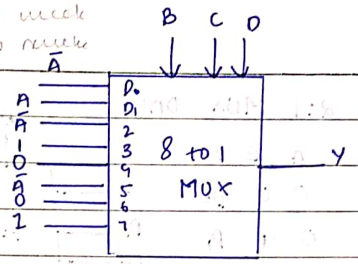
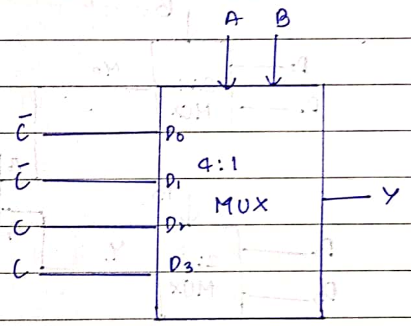


Q) Implement the given boolean function using 4 : 1 MUX
$F(A,B,C) = \Sigma m(0,2,5,7)$. Use C as Map entered Variable
Use A as Map entered variable.

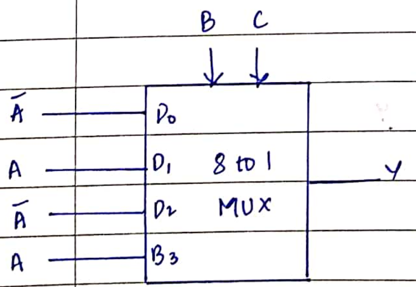
→

A	B	C	Y	
0	0	0	1	$Y = \bar{C}$
0	0	1	0	
0	1	0	1	$Y = \bar{C}$
0	1	1	0	
1	0	0	0	$Y = C$
1	0	1	1	
1	1	0	0	$Y = C$
1	1	1	1	



(II) A as MEV
Implementation Table

	D_0	D_1	D_2	D_3
$\bar{A}$	0	2	3	3
A	4	5	6	7
	↑	↑	↑	↑
	$\bar{A}$	A	$\bar{A}$	A



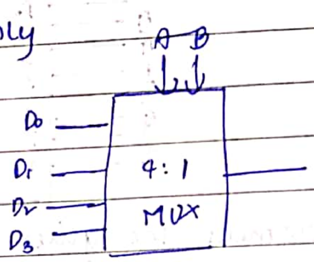
Q) Realize 4:1 MUX using 2:1 MUX only

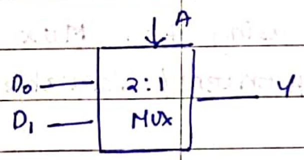
2:1

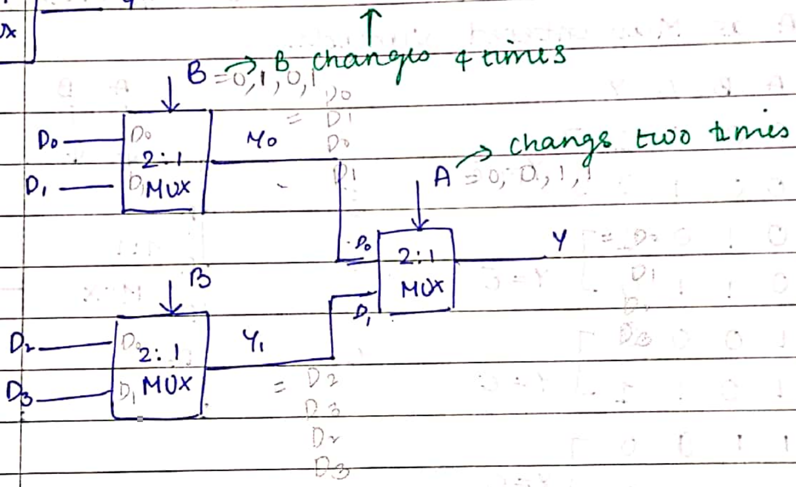
A	Y
0	D_0
1	D_1

4:1

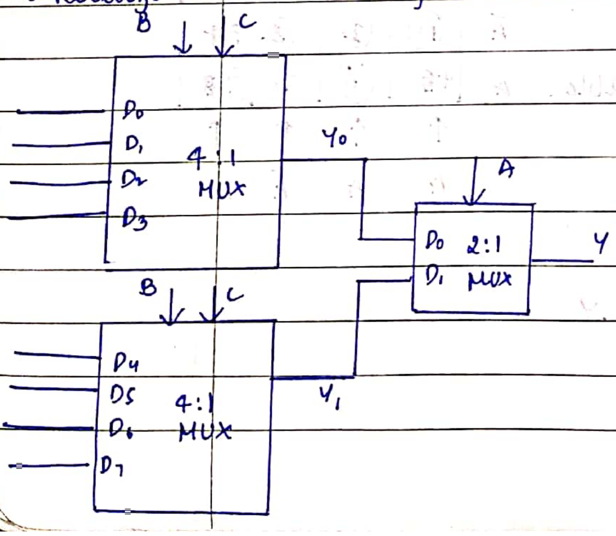
A	B	Y
0	0	D_0
0	1	D_1
1	0	D_2
1	1	D_3

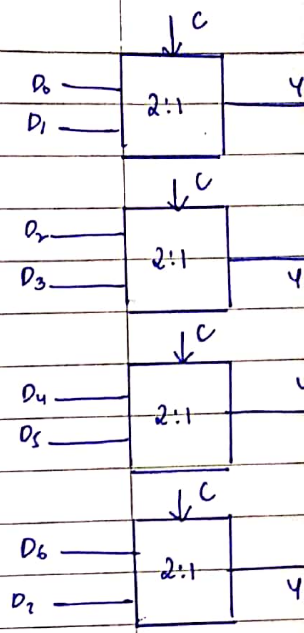




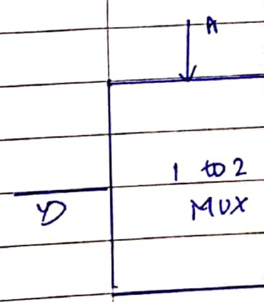


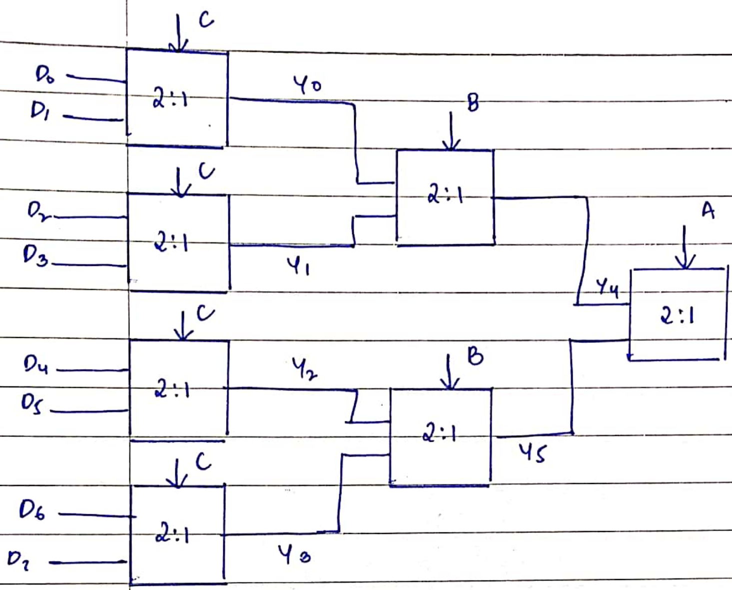
Q) Realize 8:1 MUX using 4:1 MUX s



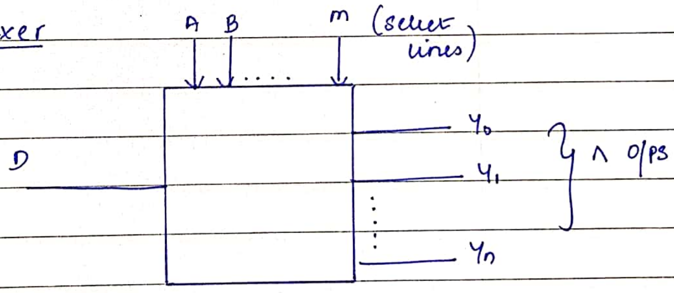


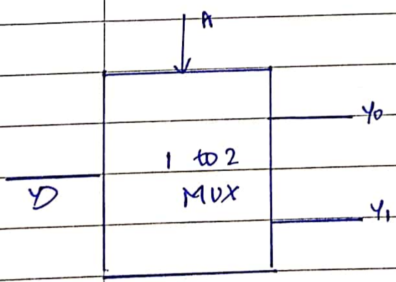
Demultip





Demultiplexer

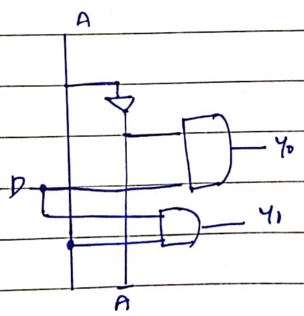




A	Y_0	Y_1
0	D	x
1	x	D

$Y_0 = \bar{A}.D$

$Y_1 = A.D$



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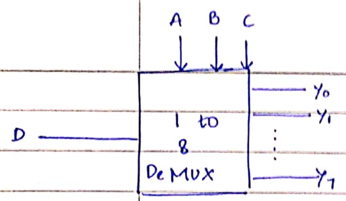


Truth Table

A	B	C	Y_0	Y_1	Y_2	Y_3	Y_4	Y_5	Y_6	Y_7
0	0	0	$\boxed{D}$	0	0	0	0	0	0	0
0	0	1	0	$\boxed{D}$	0	0	0	0	0	0
0	1	0	0	0	$\boxed{D}$	0	0	0	0	0
0	1	1	0	0	0	$\boxed{D}$	0	0	0	0
1	0	0	0	0	0	0	$\boxed{D}$	0	0	0
1	0	1	0	0	0	0	0	$\boxed{D}$	0	0
1	1	0	0	0	0	0	0	0	$\boxed{D}$	0
1	1	1	0	0	0	0	0	0	0	$\boxed{D}$

$Y_0 = ABC.D$:

$Y_1 = AB\bar{C}.D$

$Y_2 = A\bar{B}C.D$

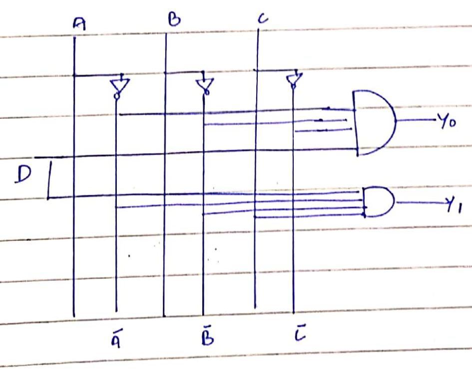
$Y_3 = A\bar{B}\bar{C}.D$

$Y_4 = \bar{A}BC.D$

$Y_5 = \bar{A}B\bar{C}.D$

$Y_6 = \bar{A}\bar{B}C.D$

$Y_7 = ABC.D$



Decorder

A decod

there is

lines o

D

S

Q.

*

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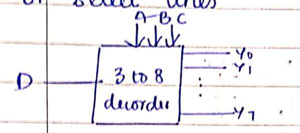
Decorder :

A decorder is similar to deMUX w 1 exception that there is no data input. The only i/p are the control lines or select lines



$Y_0 = \bar{A}\bar{B}\bar{C}$

$Y_1 = \bar{A}\bar{B}C$

⋮

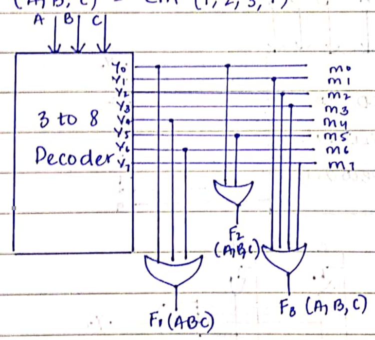
$Y_7 = ABC$

Similar like last one ; only no data line.

Q. Realize the following boolean expression using suitable decorder & multi i/p OR GATES.

$F_1(A,B,C) = \Sigma m(0,4,6)$ $F_2(A,B,C) = \Sigma m(0,5)$

$F_3(A,B,C) = \Sigma m(1,2,3,7)$



* Only OR Gates are used because SOP.

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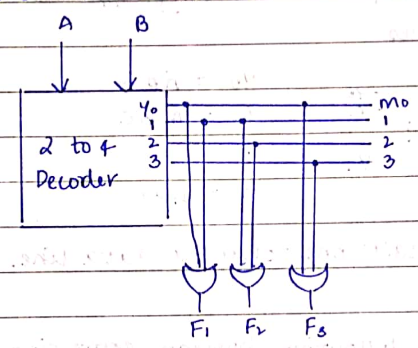
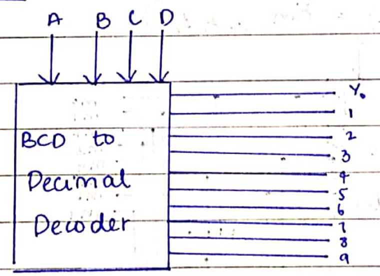
Q. $F_1(A,B) = \Sigma m(0,1)$

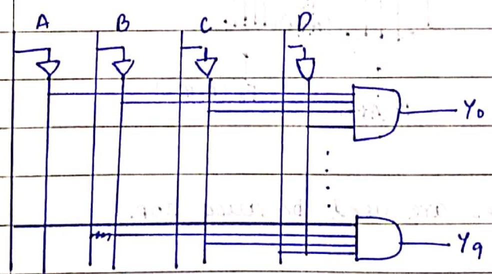
$F_2(A,B) = \Sigma m(1,2)$

$F_3(A,B) = \Sigma m(0,3)$



⇒ Realize BCD to decimal decorder using suitable deoder



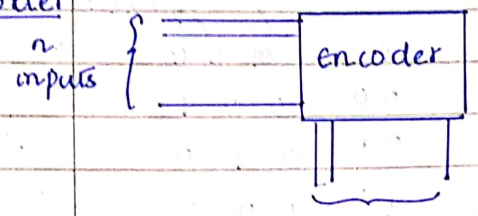


Encoder

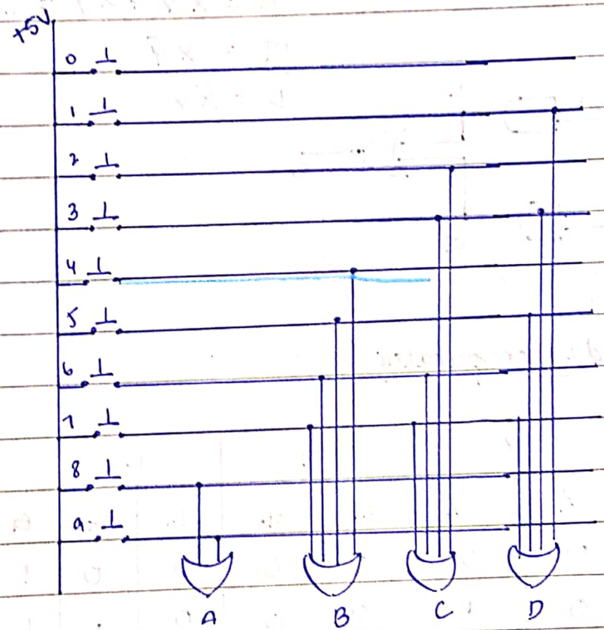
n

inpu

Encoder



Decimal to
ex. BCD Encoder.



XOR $X \oplus Y = \bar{X}Y + X\bar{Y}$

XNOR $X \odot Y = \bar{X}\bar{Y} + XY = \overline{\bar{X}Y + X\bar{Y}}$

XOR $= \bar{X}Y + X\bar{Y}$

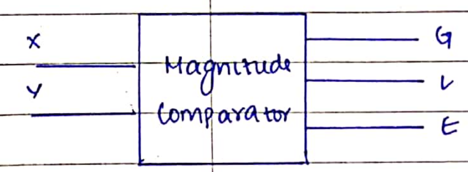
XNOR $= \overline{\bar{X}Y + X\bar{Y}} = \bar{X}\bar{Y} + XY$ //

$= \overline{\bar{X}Y} \cdot \overline{X\bar{Y}}$

$= (\bar{\bar{X}} + Y)(\bar{X} + \bar{\bar{Y}})$

$= (X + Y)(X + Y)$

Magnitude Comparator



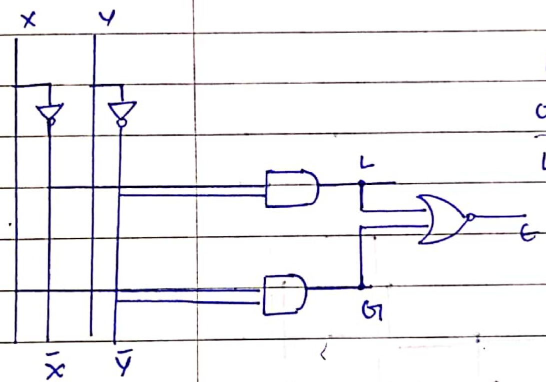
X Y	G L E
0 0	0 0 1
0 1	0 1 0
1 0	1 0 0
1 1	0 0 1

$(x > y)$ → G, $(x < y)$ → L

$E = \bar{X}\bar{Y} + XY = \overline{\bar{X}Y + \bar{Y}X} = \overline{L + G}$
$= \overline{(G + L)}$

$G = X\bar{Y}$

$L = \bar{X}Y$



2 bit Magnitude Comparator

X		Y		G		L		E	
X_1	X_0 LSB	Y_1	Y_0 LSB	G_1	G_0	L_1	L_0	E_1	E_0
0	0	0	0	0	0	0	0	1	1
0	0	0	1	0	0	0	1	1	0
0	0	1	0	0	0	1	0	0	1
0	0	1	1	0	0	1	1	0	0
0	1	0	0	0	1	0	0	1	0
0	1	0	1	0	0	0	0	1	1
0	1	1	0	0	1	1	0	0	0
0	1	1	1	0	0	1	0	0	1

X	
X_1	X_0
1	0
1	0
1	0
1	0
1	1
1	1
1	1
1	1

$X_1 X_0$

$(\bar{x}+y)$

$+xy$ //

$+G$

$1+L)$

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X		Y		G		L		E	
X_1	X_0	Y_1	Y_0	G_1	G_0	L_1	L_0	E_1	E_0
1	0	0	0	1	0	0	0	0	1
1	0	0	1	1	0	0	1	0	0
1	0	1	0	0	0	0	0	1	1
1	0	1	1	0	0	0	1	1	0
1	1	0	0	1	1	0	0	0	0
1	1	0	1	1	0	0	0	0	1
1	1	1	0	0	1	10	0	1	0
1	1	1	1	0	0	10		1	1

$\boxed{G_0}$ $X_0\bar{Y_0}$

$X_1X_0 \backslash Y_1Y_0$	00	01	11	10
00	0	0	0	0
01	1	0	0	1
11	1	0	0	1
10	0	0	0	0

$\boxed{L_0}$ $\bar{X_0}\cdot Y_0$

$X_1X_0 \backslash Y_1Y_0$	00	01	11	10
00	0	1	1	0
01	0	0	0	0
11	0	0	0	0
10	0	1	1	0

G_0 $X_0Y_0 + \bar{X_0}\bar{Y_0}$

1	0	0	1
0	1	1	0
0	1	1	0
1	0	0	1

G_1 $X_1\bar{Y_1}$

0	0	0	0
0	0	0	0
1	1	0	0
1	1	0	0

L_1 $\bar{X_1}Y_2$

0	0	1	1
0	0	1	1
0	0	0	0
0	0	0	0

$E_1 = \bar{X}\bar{Y_1} + X_1Y_1$

1	1	0	0
1	1	0	0
0	0	1	1
0	0	1	1

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$G = G_0 + G_1 = X_0 \bar{Y}_0 + X_1 \bar{Y}_1$

$L = L_0 + L_1 = \bar{X}_0 Y_0 + \bar{X}_1 Y_1$

$E = E_0 + E_1 = X_0 Y_0 + \bar{X}_0 \bar{Y}_0 + \bar{X}_1 \bar{Y}_1 + X_1 Y_1$

HW Design the priority encoder for the truth table given below priority of i/p $X_1 > X_2 > X_3$

Inputs				Outputs	
S	X_1	X_2	X_3	A	B
0	x	x	x	0	0
1	1	~~x~~	x	0	1
1	0	1	x	1	0
1	0	0	1	1	1
1	0	0	0	0	0

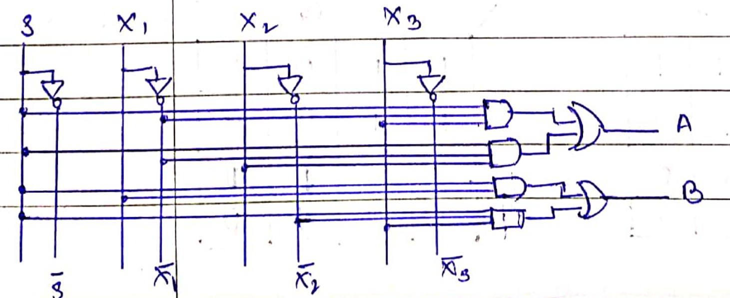
$SX_1 \backslash X_2X_3$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	0	0	0	0
10	0	1	1	1

$A = S\bar{X}_1X_3 + S\bar{X}_1X_2$

$= S\bar{X}_1(X_3 + X_2)$

$SX_1 \backslash X_2X_3$	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	0	1	0	0

$B = SX_1 + S\bar{X}_2X_3$



Exclusive

A	B
0	0
0	0
0	1
0	1
1	0
1	0
1	1
1	1

↑ Car

Even p

Q) Desig

A B C
0 0 0
0 0 1
0 1 0
0 1 1
1 0 0
1 0 1
1 1 0
1 1 1

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Exclusive OR gate

$\rightarrow$ even no. of 1 it is 0
$\rightarrow$ odd no. of 1 it is 1

A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	[illegible]

A \ BC	00	01	11	10
0	0	1	0	1
1	1	0	1	0

$Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$

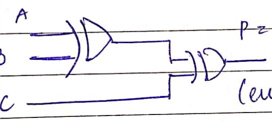
$= \bar{A}(\bar{B}C + B\bar{C}) + A(\bar{B}\bar{C} + BC)$

$= \bar{A}(B \oplus C) + A(\overline{B \oplus C})$

$P = A \oplus B \oplus C$

$\nearrow$ can be used as paraty generator & checker

Even parity generation



$P = A \oplus B \oplus C$

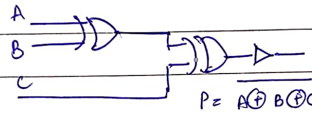
(even parity)

Q> Design odd parity generator for 3 bit binary data

ENOR $\rightarrow$ odd no. is 1
even no is 0

A B C	Y
0 0 0	1
0 0 1	0
0 1 0	0
0 1 1	1
1 0 0	0
1 0 1	1
1 1 0	1
1 1 1	0

A \ BC	00	01	11	10
0	1	0	1	0
1	0	1	0	1



$P = \overline{A \oplus B \oplus C}$

$Y = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}C + AB\bar{C}$

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

$= \bar{A}(\overline{B \oplus C}) + A(B \oplus C)$

$= \overline{A \oplus B \oplus C}$

below

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*Design even parity checker for the data received

A B C P	Y_{even}
0 0 0 0	0
0 0 0 1	1
0 0 1 0	1
0 0 1 1	0
0 1 0 0	1
0 1 0 1	0
0 1 1 0	0
0 1 1 1	1
1 0 0 0	1
1 0 0 1	0
1 0 1 0	0
1 0 1 1	1
1 1 0 0	0
1 1 0 1	1
1 1 1 0	1
1 1 1 1	0

* data is not corrupted
*. as no of ones is 0 → even but Parity P = 1 so data is corrupted ∴ y = 1 to make it even parity

K-Map

AB \ CP	00	01	11	10
00	0	1	0	1
01	1	0	1	0
11	0	1	0	1
10	1	0	1	0

$Y = \bar A\bar B\bar C P + \bar A\bar B C\bar P + \bar A B\bar C\bar P + \bar A BCP + AB\bar C P + ABC\bar P$
$+ A\bar B\bar C\bar P + A\bar B CP$

$= \bar A\bar B(\bar C P + C\bar P) + \bar A B(\bar C\bar P + CP) +$
$AB(\bar C P + C\bar P) + A\bar B(\bar C\bar P + CP)$

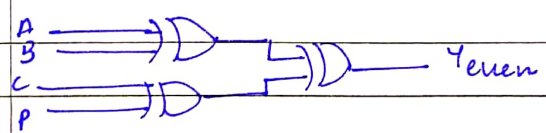
$= \bar A\bar B(C \oplus P) + AB(C \oplus P) + \bar A B(\overline{C \oplus P})$
$+ A\bar B(\overline{C \oplus P})$

$= (C \oplus P)(\bar A\bar B + AB) + (\overline{C \oplus P})(\bar A B + A\bar B)$

$= (C \oplus P)(\overline{A \oplus B}) + (\overline{C \oplus P})(A \oplus B)$

$= C \oplus P \oplus A \oplus B$

$= A \oplus B \oplus C \oplus P$



Design odd Parity checker for 3 bit binary data

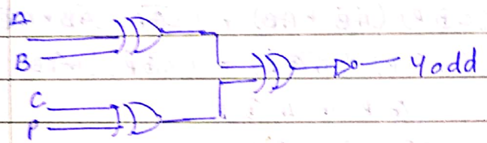
* even no. of ones there but P = 0 to make it odd add one.

A B C P	Yodd
0 0 0 0	1
0 0 0 1	0
0 0 1 0	0
0 0 1 1	1
0 1 0 0	0
0 1 0 1	1
0 1 1 0	1
0 1 1 1	0
1 0 0 0	0
1 0 0 1	1
1 0 1 0	1
1 0 1 1	0
1 1 0 0	1
1 1 0 1	0
1 1 1 0	0
1 1 1 1	1

KMAP

AB \ CP	00	01	11	10
00	1	0	1	0
01	0	1	0	1
11	1	0	1	0
10	0	1	0	1

$$Y_{odd} = \bar{A}\bar{B}\bar{C}\bar{P} + \bar{A}\bar{B}CP + \bar{A}B\bar{C}P + \bar{A}BC\bar{P} + AB\bar{C}\bar{P} + ABCP$$
$$A\bar{B}\bar{C}P + A\bar{B}C\bar{P}$$
$$= \bar{A}\bar{B}(\bar{C}\bar{P} + CP) + \bar{A}B(\bar{C}P + C\bar{P}) + AB(\bar{C}\bar{P} + CP)$$
$$+ A\bar{B}(\bar{C}P + C\bar{P})$$
$$= \overline{C \oplus P}(\bar{A}\bar{B} + AB) + C \oplus P(\bar{A}B + A\bar{B})$$
$$= \overline{C \oplus P}(\overline{A \oplus B}) + C \oplus P(A \oplus B)$$
$$= \overline{A \oplus B \oplus C \oplus P}$$

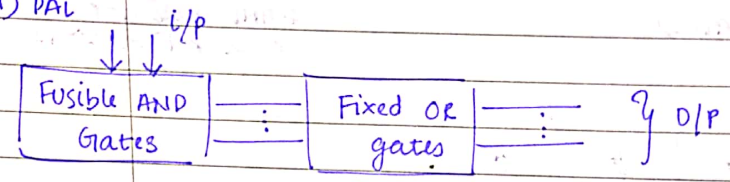


Programmable Logic Devices

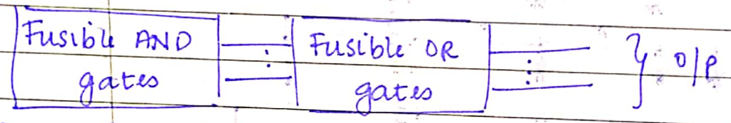
PAL Programmable Array Logic

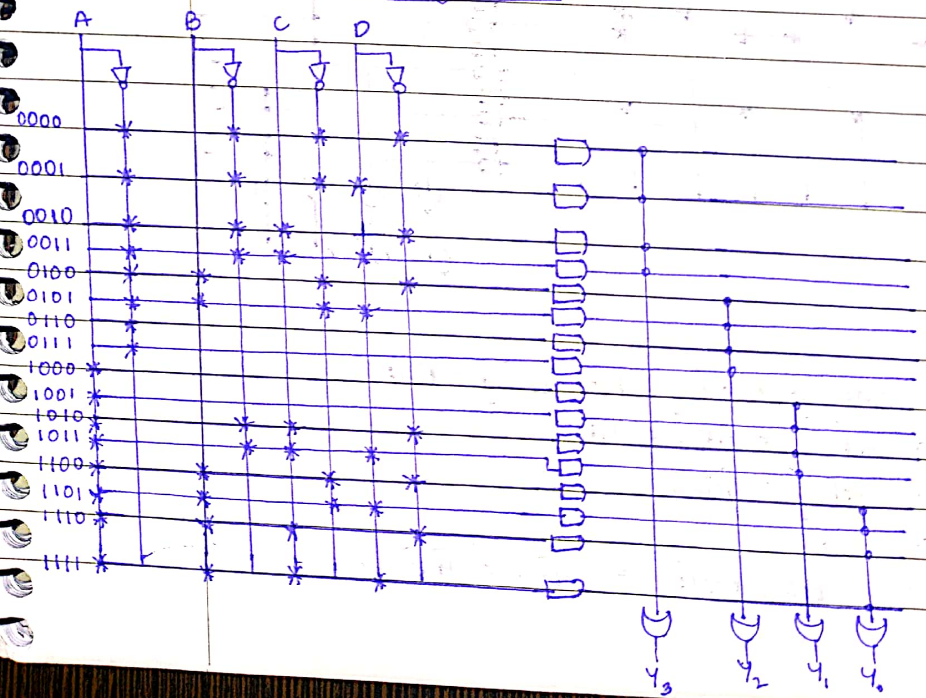
PLA Programmable Logic Array

1) PAL



2) PLA





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Generate the following BF using PAL

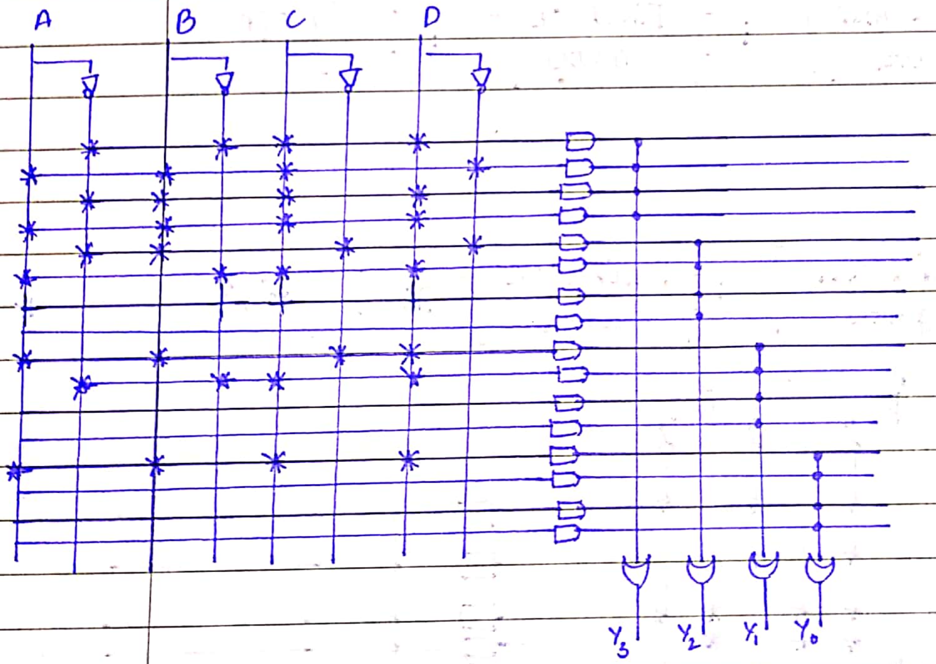
$Y_3 = \bar{A}\bar{B}CD + ABC\bar{D} + \bar{A}BCD + ABCD$

$Y_2 = \bar{A}\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D$

$Y_1 = AB\bar{C}D + \bar{A}\bar{B}CD$

$Y_0 = ABCD$

4 AND gates for each B.Functions



PLA:

Realize the following BF using PLA

$x = \bar{A}\bar{B}C + AB\bar{C} + ABC$

$y = A\bar{B}\bar{C} + \bar{A}BC$

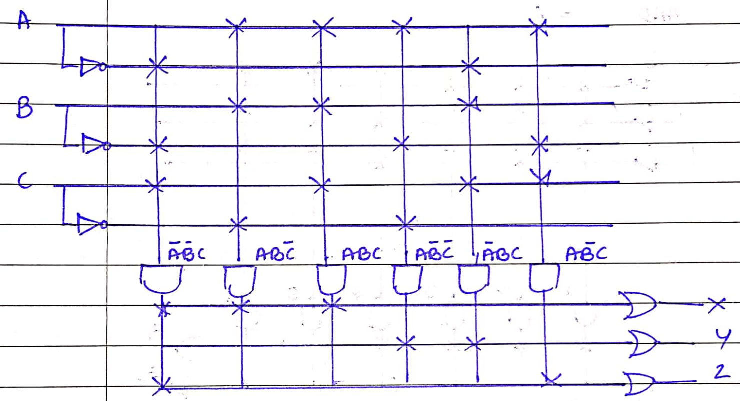
$z = \bar{B}C$

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

No. of minterms = 6 = AND

[excluding redundant minterms (repeated)

No. of boolean functions = 3 = OR



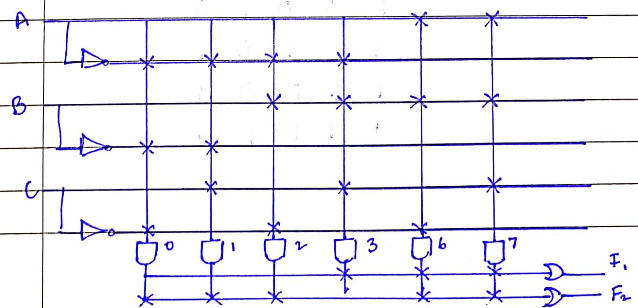
Realize the following exp using PLA

1) $F_1(x,y,z) = \Sigma m\,(3,6,7)$

$F_2(x,y,z) = \Sigma m\,(0,1,2,6,7)$

No. of boolean functions = 2 = OR Gates

" " minterms = 6 = AND gates



000
001 1
010 2
011 3
100 4
101

$C_{in} \rightarrow$ carry generated from prev addition
$C_{out} \rightarrow$ " " present addition

__/__/__

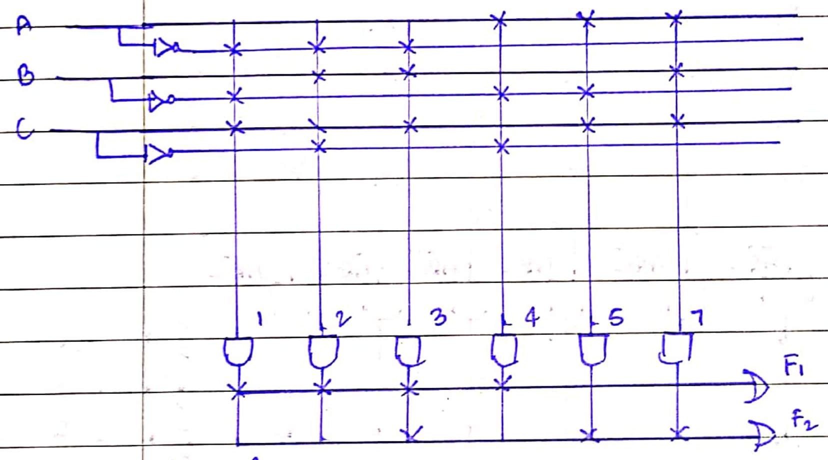
Realize using PLA

2) $F_1(x, y, z) = \Sigma m(1, 2, 3, 4)$

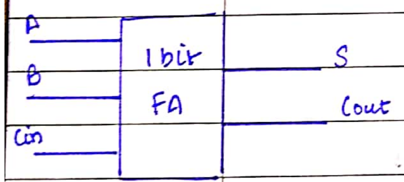
$F_2(x, y, z) = \Sigma m(3, 5, 7)$

No. of OR gates = 2

AND = 6



FULL ADDER [1 bit]



A	B	Cin	S	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

K-Map.

A \ B Cin	0
0	0
1	1

$S = \bar{A}$

$+ A$

$= \bar{A}$

$=$

$S =$

Real

1A

1 unit
Magnitude Comp.

__/__/__

K-Map for S

$A \backslash BC_{in}$	00	01	11	10
0	0	1	0	1
1	1	0	1	0

K-Map for Cout

$A \backslash BC_{in}$	00	01	11	10
0	0	0	1	0
1	0	1	1	1

$S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in}$

$+ ABC_{in}$

$= \bar{A}\,(\bar{B}C_{in} + B\bar{C}_{in}) + A(\bar{B}\bar{C}_{in} + BC_{in})$

$= \bar{A}\,(B \oplus C_{in}) + A\,(\overline{B \oplus C_{in}})$

$S = A \oplus B \oplus C_{in}$

$C_{out} = AC_{in} + AB + BC_{in}$

$C_{out} = AB + BC_{in} + C_{in}A$

Realization