Mdm 8-

Q1 1] Duality principle:- It states that every algebric expression deducible from the postulates of Boolean Algebra remains valid if the operators & identity elements are interchanged.

→ Replace OR with AND, AND with or
→ replace 1's by 0's & 0's by 1's.

2] De morgan's Theorem:-

(i) $\overline{A+B} = \bar{A}\cdot\bar{B}$

Proove:-

A	B	A+B	$\overline{A+B}$ =	$\bar{A}$	$\bar{B}$	$\bar{A}\cdot\bar{B}$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

(ii) $\overline{AB} = \bar{A}+\bar{B}$

Proove:-

A	B	AB	$\overline{AB}$ =	$\bar{A}$	$\bar{B}$	$\bar{A}+\bar{B}$
0	0	0	1	1	1	1
0	1	0	1	1	0	1
1	0	0	1	0	1	1
1	1	1	0	0	0	0

3] Associative Law:-

(i) $(A+B)+C = A+(B+C)$

A	B	C	A+B	(A+B)+C =	(B+C)	A+(B+C)
0	0	0	0	0	0	0
0	0	1	0	1	1	1
0	1	0	1	1	1	1
0	1	1	1	1	1	1
1	0	0	1	1	0	1
1	0	1	1	1	1	1
1	1	0	1	1	1	1
1	1	1	1	1	1	1

(ii) $(A \cdot B) \cdot C = A \cdot (B \cdot C)$

Prove:-

A	B	C	A·B	(A·B)·C =	B·C	A·(B·C)
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	0
0	1	1	0	0	1	0
1	0	0	0	0	0	0
1	0	1	0	0	0	0
1	1	0	1	0	0	0
1	1	1	1	1	1	1

4] Distributive law:-

(i) $A \cdot (B + C) = AB + AC$

Prove:-

A	B	C	B+C	A·(B+C) =	AB	AC	AB+AC
0	0	0	0	0	0	0	0
0	0	1	1	0	0	0	0
0	1	0	1	0	0	0	0
0	1	1	1	0	0	0	0
1	0	0	0	0	0	0	0
1	0	1	1	1	0	1	1
1	1	0	1	1	1	0	1
1	1	1	1	1	1	1	1

(ii) $A + BC = (A + B) \cdot (A + C)$

A	B	C	BC	A+BC =	A+B	A+C	(A+B)·(A+C)
0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0
0	1	0	0	0	1	0	0
0	1	1	1	1	1	1	1
1	0	0	0	1	1	1	1
1	0	1	0	1	1	1	1
1	1	0	0	1	1	1	1
1	1	1	1	1	1	1	1

5] Absorption law:-

(i) $A + A \cdot B = A$

A	B	$A \cdot B$	$A + A \cdot B = A$
0	0	0	0
0	1	0	0
1	0	0	1
1	1	1	1

(ii) $A(A+B) = A$

A	B	$A+B$	$A \cdot (A+B) = A$
0	0	0	0
0	1	1	0
1	0	1	1
1	1	1	1

6] Commutative law:-

(i) $A + B = B + A$

A	B	$A+B$	$= B+A$
0	0	0	0
0	1	1	1
1	0	1	1
1	1	1	1

(ii) $A \cdot B = B \cdot A$

A	B	$A \cdot B$	$= B \cdot A$
0	0	0	0
0	1	0	0
1	0	0	0
1	1	1	1

Q2 Define:-

1] Min terms:- POS

A 'product term which contains all the variables of the ~~SHA~~ funn either in complemented or uncomplemented form is called min term.

2] Max term:-

A sum term which contains all the variables of a funn in either complemented or uncomplemented form is called max term.

(iii) Canonical form:-

In Boolean Algebra, Boolean funⁿ can be expressed as canonical disjunctive normal form known as minterm & some are expressed as canonical conjunctive normal form known as maxterm.

(iv) Std form:-

In Std form, Boolean funⁿ will contain all the variables in either true form or complemented form.

(V) positive logic system:-

In which higher of the two voltage levels represents 1 & lower of the two voltage level represents logic 0.

(vi) Negative logic system:-

In which higher of the two voltage levels represents logic 0 & the lower of the two voltage level represents logic 1.

Q3. (i) propagation Delays.

It is the amt of time it takes for the head of the signal to travel from the sender to receiver.

(ii) power Dissipation:-

The process in which an electric or electronic device produces heat as an unwanted by product of its primary action.

Q4 How many funⁿ can be formed with n variable in Boolean algebra?

→ 2^n.

Q5 Dual & complement:-

(i) $f_1 = x'y'z' + x'yz'$

Dual:- $(x'+y'+z')\cdot(x'+y+z')$

complement:- $(x+y+z)\cdot(x+y'+z)$

(2) $f_2 = x'(y'z' + yz)$

Dual:- $x' + y'+z' \cdot (y+z)$

complement:- $x+y+z\cdot(y'+z')$

3) $f_3 = xy + x'z + yz$

Dual :- $((x+y)\cdot(x'+z)\cdot(y+z)$

complement $= (x'+y')\cdot(x+z')\cdot(y'+z')$

Q6 Truth table:- $f_1 = x(y'z'+yz)$

x	y	z	y'	z'	$y'\cdot z'$	$y\cdot z$	$y'z'+yz$	$x(y'z'+yz)$
0	0	0	1	1	1	0	1	0
0	0	1	1	0	0	0	0	0
0	1	0	0	1	0	0	0	0
0	1	1	0	0	0	1	1	0
1	0	0	1	1	1	0	1	1
1	0	1	1	0	0	0	0	0
1	1	0	0	1	0	0	0	0
1	1	1	0	0	0	1	1	1

Q7 Simplify to minimum no. of literals:-

(i) $x + x'y$

$(x+x')\cdot(x+y)$

$1\cdot(x+y)$

$= x+y$

2) $x(x'+y)$

$xx' + xy$

$0 + xy$

xy

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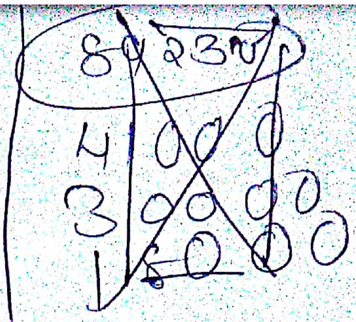


3) $x'y'z + x'yz + xy'$

$x'z(y'+y) + xy'$

$\Rightarrow x'z + xy'$

4] $xy + x'z + yz$

$xy + x'z + yz(x+x')$

$xy + x'z + yzx + yzx'$

$xy(1+z) + x'z(1+y)$

$xy + x'z$.

5] $(x+y)(x'+z)(y+z)$

$(xx' + xz + x'y + yz)(y+z)$

$\Rightarrow \underset{0}{xx'y} + \underset{0}{xx'z} + xyz + xz\cdot z + x'y\cdot y + x'yz + y\cdot y\cdot z + yz\cdot z$

$\Rightarrow$

$\Rightarrow xyz + xz + x'y + x'yz + yz + yz$

$\Rightarrow xyz + xz + x'y + x'yz + yz$

$\Rightarrow yz(x+x') + xz + x'y + yz$

$\Rightarrow yz + xz + x'y + yz \Rightarrow xz + x'y + yz$.

Q9 Convert in canonical form:-

1) $f(x,y,z) = \Sigma(1,3,7)$

cf:- $\Pi(0,2,4,5,6)$

2) $f(x,y,z) = \Pi(1,3)$

cf:- $\Sigma(0,2,4,5,6,7)$

3) $f(x,y,z) = \Sigma(1,3,5,2,11,15)$

cf:- $\Pi(0,4,6,7,8,9,10,12,13,14)$

Q8 Express the Boolean funⁿ in:

a) SOP. b) POS

SOP	$A' = 0$
	8 4 2 1
POS	$A' = 1$

(i) $F = A + B'C + A'B$

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

a) SOP:- $A(B+B')\cdot(C+C') + B'C(A+A') + A'B(C+C')$

$\Rightarrow (AB+AB')(C+C') + AB'C + A'B'C + A'BC + A'BC'$

$\Rightarrow ABC + ABC' + \underline{AB'C} + AB'C' + \underline{AB'C} + A'B'C + A'BC + A'BC'$

$\Rightarrow ABC + ABC' + AB'C + AB'C' + A'B'C + A'BC + A'BC'$

$\Rightarrow 111 + 110 + 101 + 100 + 001 + 011 + 010$

$\Rightarrow 7 + 6 + 5 + 4 + 1 + 3 + 2$

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

b) POS:- $\Sigma\Pi(0)$

(ii) $F = xy + x'z$.

a) SOP:- $xy(z+z') + x'z(y+y')$

$\Rightarrow xyz + xyz' + x'zy + x'y'z$

$= 111 + 110 + 011 + 001$

$\Rightarrow 7, 6, 3, 1$.

$\Sigma m(1,3,6,7)$

b) POS:- $(xy+x')\cdot(xy+z)$

$:- (x'+x)\cdot(x'+y)\cdot(x+z)\cdot(z+y)$

$:- (x'+y)\cdot(x+z)\cdot(z+y)$

$:- (x'+y+z)\cdot(x'+y+z')\cdot(x+y+z)\cdot(x+y'+z)\cdot(x+y+z)\cdot(x'+y+z)$

$\Rightarrow (x+y+z)(x'+y+z')\cdot(x+y'z)\cdot(x'+y+z')$

$\Rightarrow$ ~~1 1 1, 0 1 0, 1 0 1, 0 1 0~~

$(000)\cdot(100)\cdot(010)\cdot(101)$

$\Rightarrow 0, 5, 2, 4$ $\quad \Sigma\Pi(0,2,4,5)$

Q10 Differenie betn canonical & std form:-

Cf:- Each term must & should contains all literals corresponding to each variable of the funn.

Sf:- Each term doesn't contains literal corresponding to each variable of the funn. i.e it may contains one or two or any no of literals.

Q13. Dual - exclusive OR gate is equal to its complement

Ex-OR:- $A\bar{B} + \bar{A}B = f$

dual:- $(A + \bar{B}) \cdot (\bar{A} + B)$

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

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

:- f'

Q14 Limitation of K-map:-

It becomes difficult to visualize for more than 5 variables.

Q15, which code is used in K-map? Gray code

Q16 Simplify:- $f = x'y'z' + x'y'z + xy'z' + xy'z$

$\Rightarrow x'y'(z'+z) + xy'(z'+z)$

$\Rightarrow x'y' + xy'$

$\Rightarrow y'(x'+x) \Rightarrow y'$.

Q17 why NAND & NOR gate is called universal gate?

Because any digital circuit of any complexity can be built by using only NAND or only NOR gate.

Q2 SOP using k-map:-

1) $x'z + w'xy' + wx'y + wxy'$

$\Rightarrow x'z(y+y') + w'xy'(z+z') + wx'y(z+z') + wxy'(z+z')$

$\Rightarrow x'yz + x'y'z + w'xy'z + w'xy'z' + wx'yz + wx'yz'$
$+ wxy'z + wxy'z'$

$\Rightarrow x'yz(w+w') + x'y'z(w+w') + w'xy'z + w'xy'z' + wx'yz$
$+ wx'yz' + wxy'z + wxy'z'$

$\Rightarrow wx'yz + w'x'yz + wx'y'z + w'x'y'z + w'xy'z + w'xy'z'$
$+ wx'yz + wx'yz' + wxy'z + wxy'z'$

$\Rightarrow 1011 + 0011 + 1001 + 0001 + 0101 + 0100 + 1011 + 1010$
$+ 1101 + 1100.$

8421

$\Rightarrow 11, 3, 9, 1, 5, 11, 10, 13, 12, 4$

$\Rightarrow \Sigma m(1, 3, 4, 5, 9, 10, 11, 12, 13)$

wx \ yz	00	01	11	10
00		1	1	
01	1	1		
11	1	1		
10	a	1	1	1

$\Rightarrow x \cdot \bar{y} + \bar{x}z + w\bar{x}y$ — Ans.

2) $B'D + A'BC' + ACD + A'BC$.

$\Rightarrow B'D(A+A') + A'BC'(D+D') + ACD(B+B') + A'BC(D+D')$

$\Rightarrow AB'D + A'B'D + A'BC'D + A'BC'D' + ABCD + AB'CD$
$+ A'BCD + A'BCD'$

$\Rightarrow AB'D(C+C') + A'B'D(C+C') + A'BC'D + A'BC'D' + ABCD$
$+ AB'CD + A'BCD + A'BCD'$.

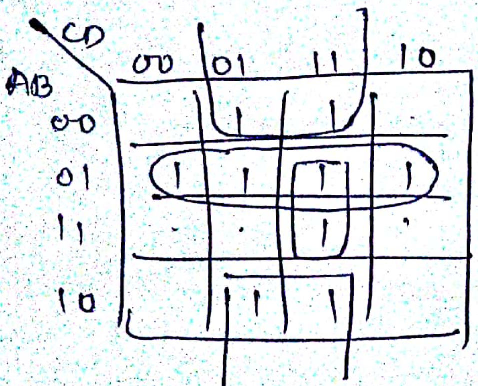
$\Rightarrow AB'CD + AB'C'D + A'B'CD + A'B'C'D + A'BC'D$
$+ A'BC'D' + ABCD + AB'CD + A'BCD + A'BCD'$.

$= 1011 + 1001 + 0011 + 0001 + 0101 + 0100 + 1111 +$
$1011 + 0111 + 0110$

8421

$\Rightarrow 11, 9, 3, 1, 5, 4, 15, 11, 7, 6$.

$\Rightarrow \Sigma m(1, 3, 4, 5, 6, 7, 9, 11, 15)$



$\Rightarrow \bar{A}B + \bar{B}D + BCD$.

3) $f(a,b,c,d,e) = \Sigma(0,2,4,6,9,11,13,15,17,21,25,27,29,31)$

A

BC \ DE (A = 0)	00	01	11	10
00	1	.	.	1
01	1	.	.	1
11	.	1	1	
10	.	1	1	

BC \ DE (A = 1)	00	01	11	10
00	.	1		
01	.	1		
11	.	1	1	
10	.	1	1	

$\Rightarrow$ A ~~BD~~ $\Rightarrow BE + \bar{A}\bar{B}\bar{E} + A\bar{D}E$.

Q3 (i) $f(w,x,y,z) = \Sigma(1,3,7,11,15)$ $d(w,x,y,z) = \Sigma(0,2,5)$.

wx \ yz	00	01	11	10
00	X	1	1	X
01	.	X	1	.
11	.	.	1	.
10	.	.	1	.

$\Rightarrow yz + \bar{w}\bar{x}$

(ii) $f = A'B'D' + A'CD + A'BC$ $d = A'BC'D + ACD + AB'D'$.

$f = A'B'CD' + A'B'C'D' + A'BCD + A'B'CD + A'BCD + A'BCD'$

$\Rightarrow 0010 + 0000 + 0111 + 0011 + 0111 + 0110$

$\Rightarrow 2, 0, 7, 3, 6 = \Sigma m(0,2,3,6,7)$

8.4.21

$d = A'BC'D + ABCD + AB'CD + AB'CD' + AB'C'D'$

$= 0101 + 1111 + 1011 + 1010 + 1000$

$\Rightarrow 5, 15, 11, 10, 8.$

$\Sigma d = (5, 8, 10, 11, 15)$

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

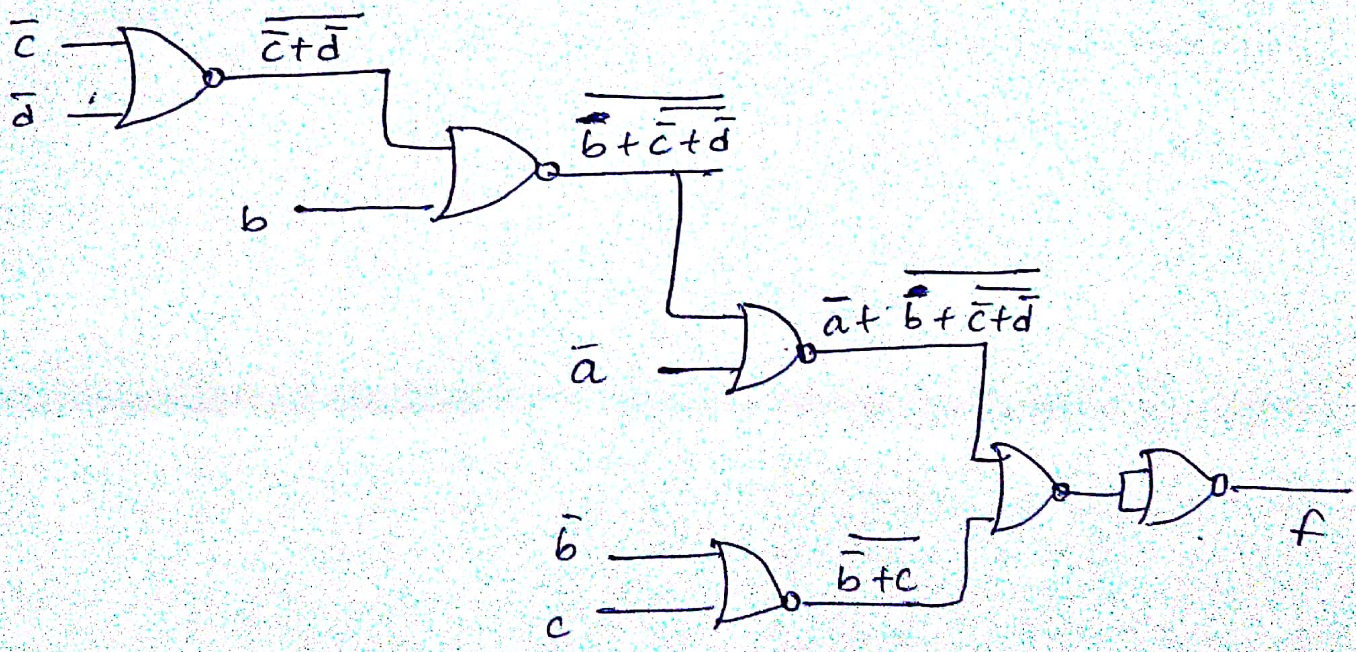
$\Rightarrow \bar{A}C + \bar{B}D$

Q4. using NOR Gates:-

(i) $f = A(B+CD) + BC'$

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

$$\Rightarrow \overline{\bar{a} + \overline{(B + \bar{C} + \bar{D})}} + \overline{\bar{b} + c}$$



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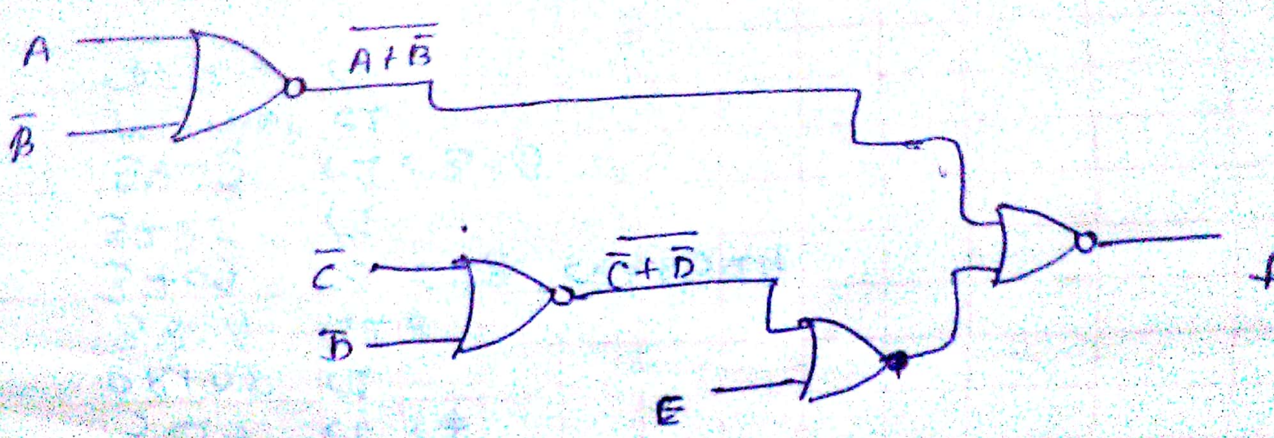
(ii) $(A+B')\cdot(CD+E)$

$\Rightarrow \overline{\overline{(A+B')\cdot(\overline{\overline{CD}}+E)}}$

$\Rightarrow \overline{\overline{(A+\overline{B'})} + (\overline{\overline{C}+\overline{D}+E})}$



Q5 Using NAND gate:-

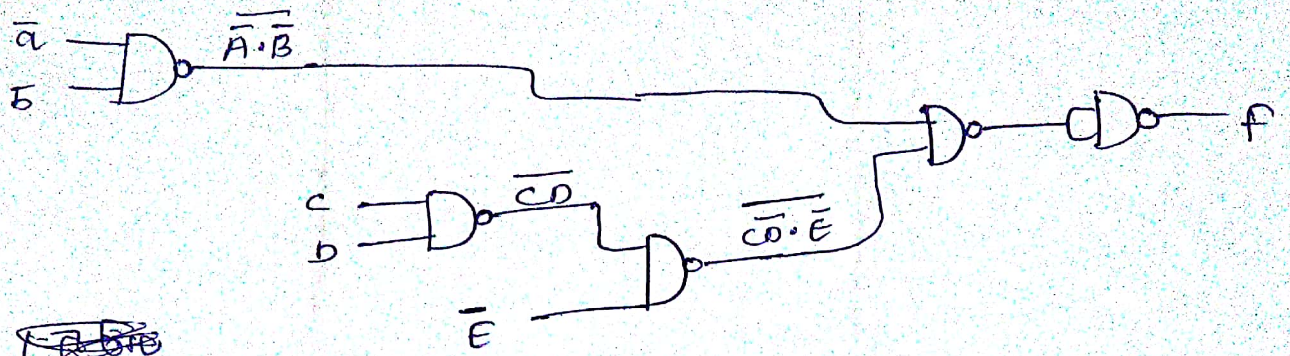
(i) $F = (A+B)(CD+E)$

$\Rightarrow (\overline{\overline{A+B}})(\overline{\overline{CD+E}})$

$\Rightarrow (\overline{\overline{A}\cdot\overline{B}})(\overline{\overline{CD}\cdot\overline{E}})$

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

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

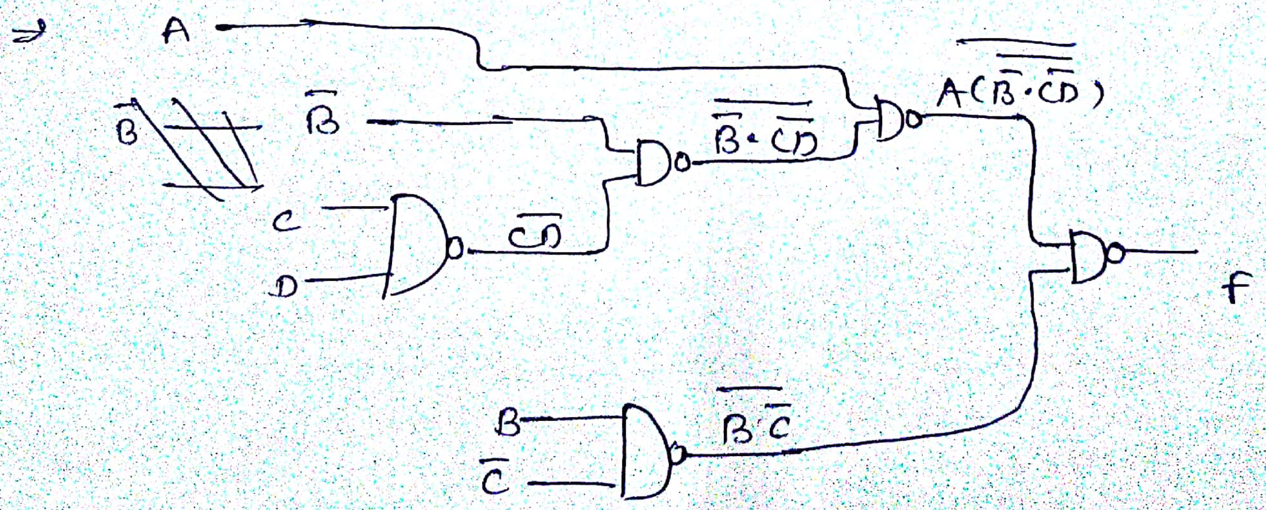


(ii) $f = A(B+CD) + BC'$.

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

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

$$\Rightarrow \overline{\overline{A(\overline{\bar{B}\cdot\overline{CD}})}\cdot\overline{B\bar{C}}}$$



06 tabulation method:-

$f = \Sigma(0,1,2,8,10,11,14,15)$

0 → 0000
1 → 0001
2 → 0010
8 → 1000
10 → 1010
11 → 1011
14 → 1110
15 → 1111

①

Index	BR	Minterm
0	0000	0
1	0001 0010 1000	1 2 8
2	1010	10
3	1011 1110	11 14
4	1111	15

②

~~BR~~ Minterm	BR
(0,1)	000 –
(0,2)	00 – 0
(0,8)	– 000
(1,10)	–
(2,10)	– 010
(8,10)	10 – 0
(10,11)	101 –
(10,14)	1 – 10
(11,15)	1 – 11
(14,15)	111 –

③

Minterm	BR ABCD
(0,2,8,10)	– 0 – 0
(0,8,2,10)	– 0 – 0
(10,11,14,15)	1 – 1 –
(10,14,11,15)	1 – 1 –
(0,1)	000 –

⇒ $\bar{B}\bar{D} + AC + \bar{A}\bar{B}\bar{C}$ Ans.

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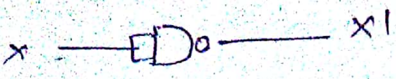
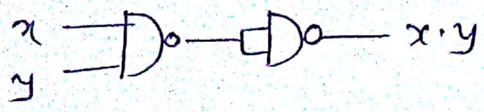
NAND

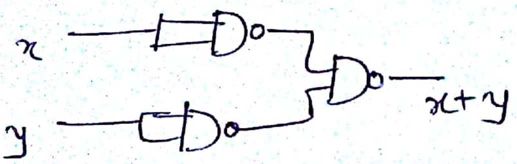
NOT:-



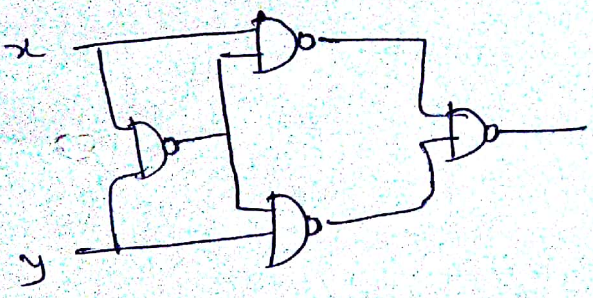
AND:-



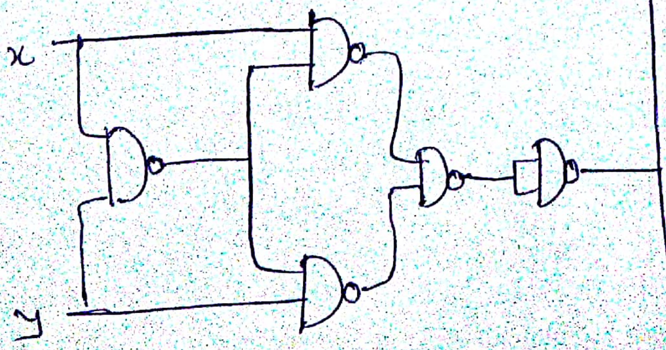
OR:-



XOR:-



XNOR:-



NOR