Session 7 & 8 Terminal Questions

① Design given logic function using NAND gates.

$$F(A,B,C) = A + B\cdot C$$

Apply double complement on both sides.

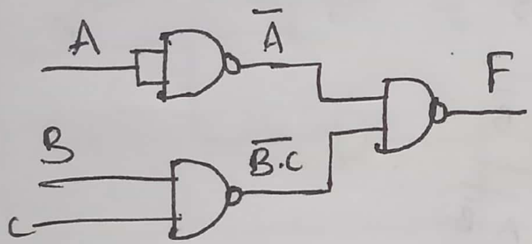
$$\overline{\overline{F}} = \overline{\overline{A + B\cdot C}}$$ apply demorgan's Theorem. $\overline{X+Y} = \overline{X}\cdot\overline{Y}$

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

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

$X = \overline{A}$

$Y = \overline{B\cdot C}$



② Design given logic function using NOR gates

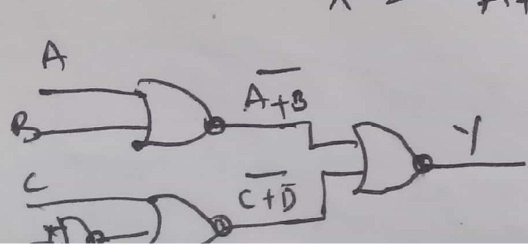
$$Y = (A+B)\cdot(C+D')$$

$$\overline{\overline{Y}} = \overline{\overline{(A+B)\cdot(C+\overline{D})}}$$ apply Demorgan's Theorem.

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

$$Y = \overline{X + Y}$$

$X = \overline{A+B}$, $Y = \overline{C+\overline{D}}$



③ Design given logic function using NAND gates. $F = \bar{A}\cdot B + A\cdot\bar{B}$

$$F = \bar{A}\cdot B + A\cdot\bar{B}$$

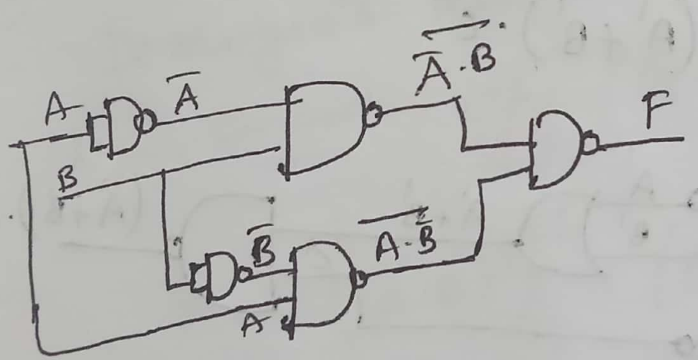
$$\bar{\bar{F}} = \overline{\overline{\bar{A}\cdot B + A\cdot\bar{B}}}$$

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

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

$X = \overline{\bar{A}\cdot B}$

$Y = \overline{A\cdot\bar{B}}$



Demorgan's Theorem based problems

① Simplify the expression using De Morgan's Theorem and draw the logic circuit.

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

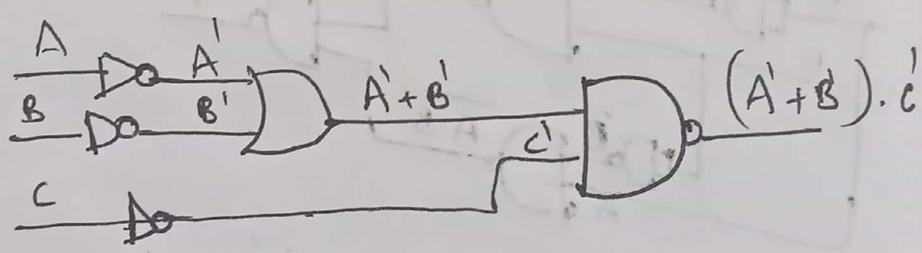
Sol: By applying Demorgan's theorem

$$(X + Y)' = X' \cdot Y'$$

$$Y = (A \cdot B)' \cdot C'$$

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

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



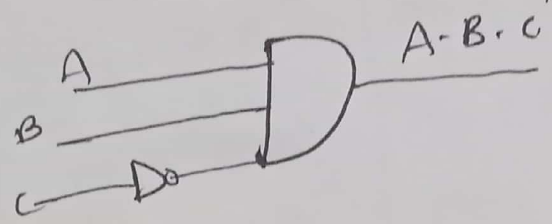
(2) Simplify the expression using De-Morgan's Theorem and draw the logic circuit.

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

$$\boxed{(X')' = X}$$

Sol: $Y = ((A \cdot B)')' \cdot C'$

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



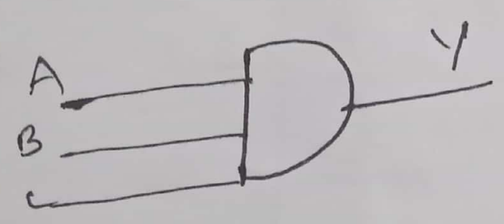
(3) Simplify the expression using the De Morgan's Theorem and draw the logic circuit. $Y = ((A \cdot B)' + C')'$

Note

$$\boxed{((X)')' = X}$$

Sol: $Y = ((A \cdot B)')' \cdot (C')'$

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



Long-Answer

Session - 9 Terminal Questions

3. Create Seperate tables listing Min and Max terms for 2-variables (A, B) and 3-variables (A, B, C).

A	B	Minterm	Maxterm
0	0	$m_0 = \bar{A} \cdot \bar{B}$	$M_0 = A + B$
0	1	$m_1 = \bar{A} \cdot B$	$M_1 = A + \bar{B}$
1	0	$m_2 = A \cdot \bar{B}$	$M_2 = \bar{A} + B$
1	1	$m_3 = A \cdot B$	$M_3 = \bar{A} + \bar{B}$

A	B	C	Minterm	Maxterm
0	0	0	$m_0 = \bar{A} \cdot \bar{B} \cdot \bar{C}$	$M_0 = A + B + C$
0	0	1	$m_1 = \bar{A} \cdot \bar{B} \cdot C$	$M_1 = A + B + \bar{C}$
0	1	0	$m_2 = \bar{A} \cdot B \cdot \bar{C}$	$M_2 = A + \bar{B} + C$
0	1	1	$m_3 = \bar{A} \cdot B \cdot C$	$M_3 = A + \bar{B} + \bar{C}$
1	0	0	$m_4 = A \cdot \bar{B} \cdot \bar{C}$	$M_4 = \bar{A} + B + C$
1	0	1	$m_5 = A \cdot \bar{B} \cdot C$	$M_5 = \bar{A} + B + \bar{C}$
1	1	0	$m_6 = A \cdot B \cdot \bar{C}$	$M_6 = \bar{A} + \bar{B} + C$
1	1	1	$m_7 = A \cdot B \cdot C$	$M_7 = \bar{A} + \bar{B} + \bar{C}$

4. Minimize the given Product of Sum (POS) using Boolean laws and sketch the logic circuit

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

<u>Sol:-</u>

$$Y = (A.A + A.\bar{B} + A.B + B\bar{B})(\bar{A}+B)$$

$$= (A + A.\bar{B} + A.B + 0)(\bar{A}+B)$$

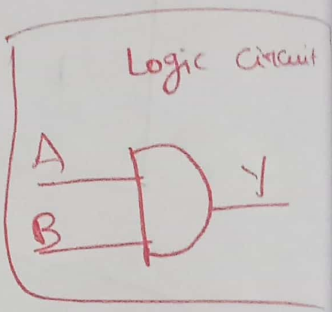
$$= (A + A[B+\bar{B}])(\bar{A}+B)$$

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

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

$$= A.\bar{A} + AB$$

$$\boxed{Y = AB}$$



5. Minimize the given sum of products (SOP) using Boolean laws and sketch the logic circuit.

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

<u>Sol:-</u>

$$F = A\bar{B}C + AB[\bar{C}+C]$$

$C+\bar{C} = 1$

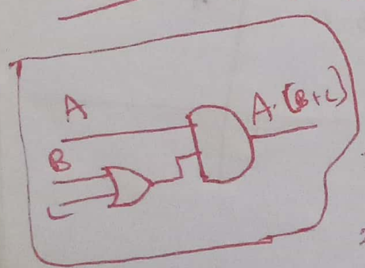
$$= A\bar{B}C + AB$$

$$= A[\bar{B}C + B]$$

$B+\bar{B} = 1$

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

$$F = A.[B+C]$$

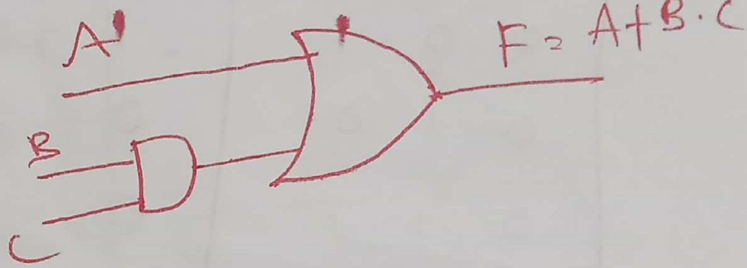


6. Minimize the given Sum of products (SOP) using Boolean laws and sketch the logic circuit.

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

$$F = A[C+\bar{C}] + B\cdot C$$

$$\boxed{F = A + B\cdot C}$$



Short Answer Questions

1. Develop a truth table that represents the Boolean equation.

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

$$= \sum m(1, 4, 6, 7).$$

A	B	C	F
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	1
1	1	1	1

2. Develop a truth table and express the Boolean function in minterm form.

$$F = \bar{A}B + A\bar{B} + ABC$$

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

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

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

$$\boxed{F = \sum m(2,3,4,5,7)}$$

Example: 72-58 (Using 1's Complement)

Step 1: 72 in binary (8-bit) → 01001000

58 in binary (8-bit) → 00111010

Step 2:- 1's complement of subtrahend (58)

11000101

Step 3. Add minuend + 1's complement of subtrahend

```
  1
  01001000
  11000101
+
[1] 00001101
```

End around carry

→ Add carry to the result.

```
           1
  00001101
         1
  --------
  00001110
```

Step 4: Result - 00001110

Decimal Equalant → 14

Example: Perform the 2's complement Subtraction on given decimal values.

89 - 27.

Step 1: 89 in binary → $(01011001)_2$

26 in binary → $(00011010)_2$

Step 2: Take 2's complent of Subtrahend (26).

2's complent = 1's complement + 1

1's comp of 26 → 1 1 1 0 0 1 0 1

Add 1   1

1 1 1 0 0 1 1 0

Step 3: Add minuend with 2's complent of Subtrahend.

minuend = 89 →		0 1 0 1 1 0 0 1
2's compent of 26 →	+	1 1 1 0 0 1 1 0
	1	0 0 1 1 1 1 1 1

1 ↓ Discard Carry

Step 4: Interpret the result → 63.

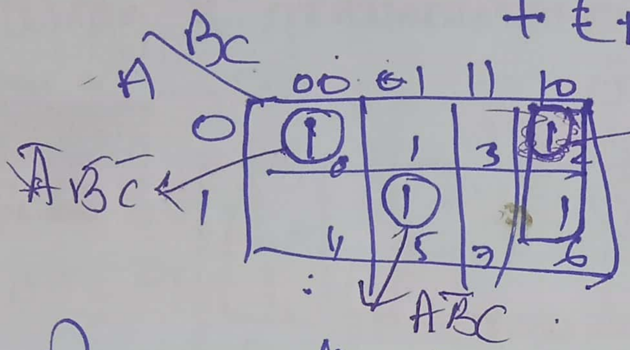
00111111

Terminal Questions on K-maps

SAQ's

1) Optimize 3 variable function

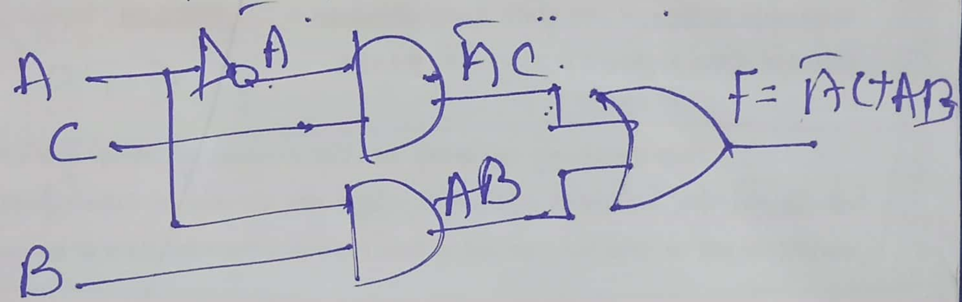
$F(A,B,C) = \Sigma m(0,2,5,6)$



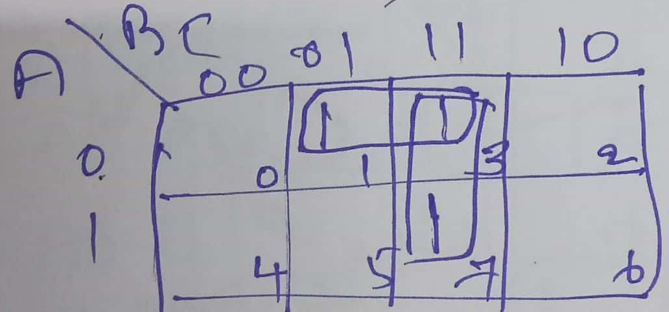
$F(A,B,C) = B\bar{C} + \bar{A}\bar{B}\bar{C} + A\bar{B}C$

2) Realize the logic diagram for the function,

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



3) Derive the simplified Boolean expression for $F(A,B,C) = \Sigma m(1,3,7)$



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

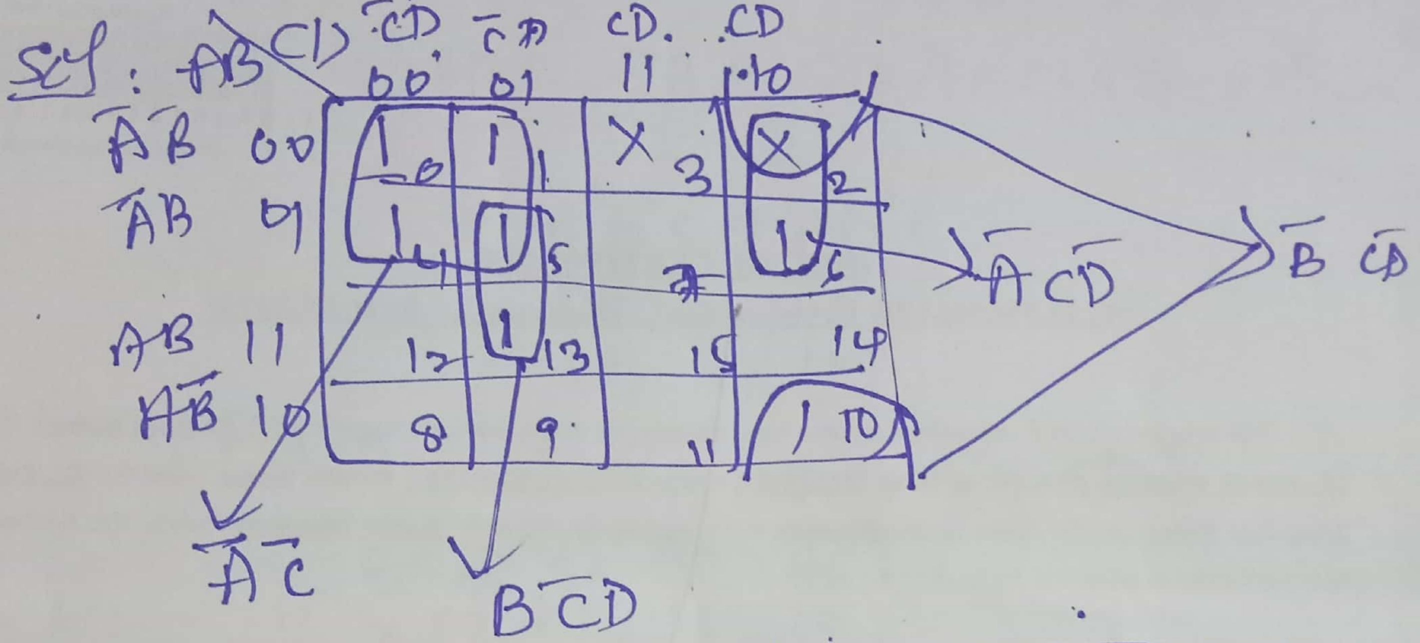
LAQ

1) optimize four variable function

$F(A,B,C,D) = \Sigma m(0,1,4,5,6,10,13) + d(2,3)$

using K-maps.

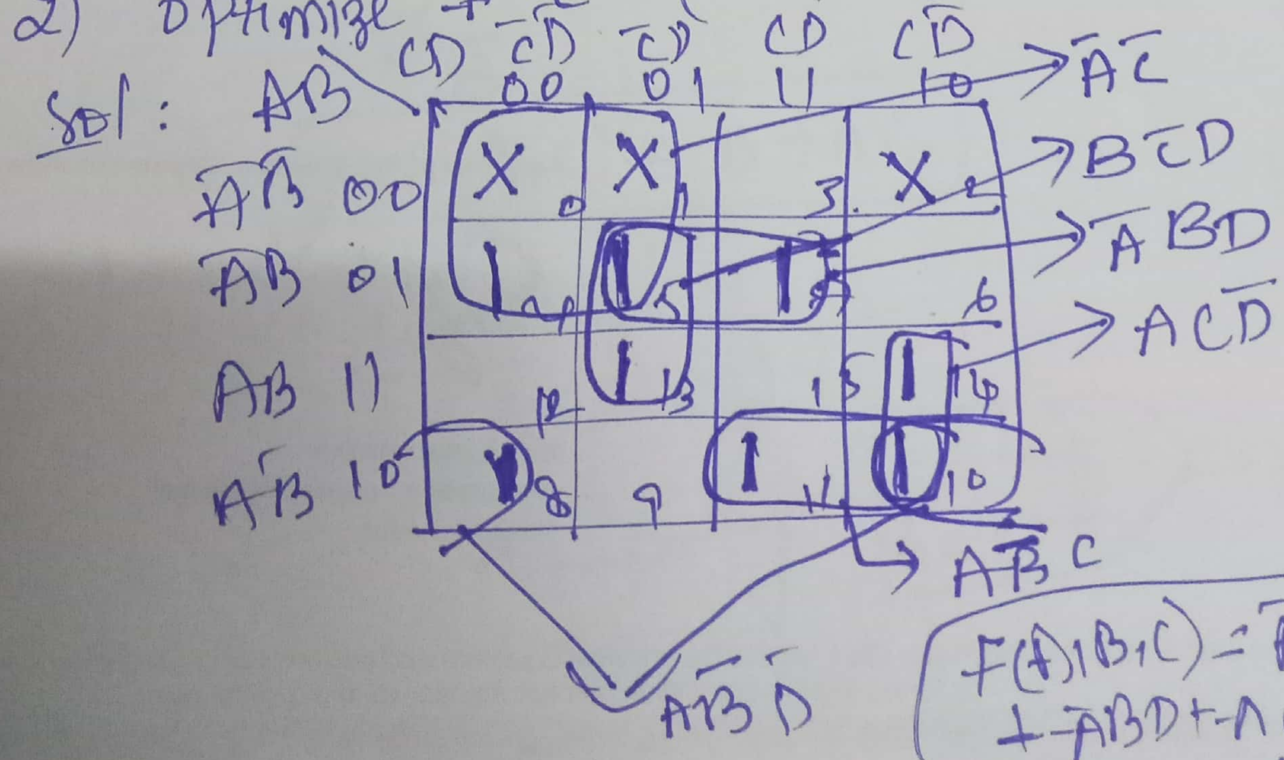
Sol:



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

2) optimize $F = \Sigma m(4,5,7,8,10,11,13,14) + d(0,1,2)$

Sol:



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

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3. Optimize $F(A,B,C) = AB'C + A'B'C + A'BC + A'B'C' + AB'C'$ using K-maps and realize the resultant expression using logic gates.

Sol:- Given, $F(A,B,C) = \underset{(5)\,101}{AB'C} + \underset{(1)\,001}{A'B'C} + \underset{(3)\,011}{A'BC}$

$+ \underset{000\,(0)}{A'B'C'} + \underset{100\,(4)}{AB'C'}$

$F(A,B,C) = \Sigma m(0,1,3,4,5)$

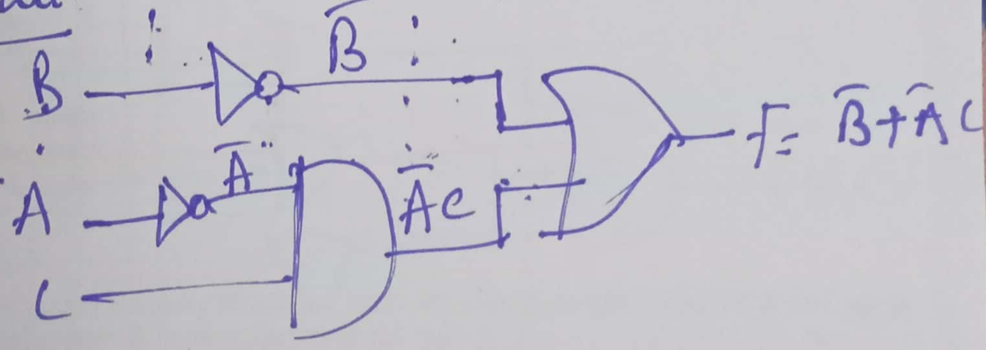
A \ BC	$\bar{B}\bar{C}$ 00	$\bar{B}C$ 01	BC 11	$B\bar{C}$ 10
$\bar{A}$ 0	1 (0)	1 (1)	1 (3)	(2)
A 1	1 (4)	1 (5)	(7)	(6)

$\rightarrow \bar{A}C$

$\bar{B}$

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

Logic circuit



4. Minimize the given POS using K-map and Construct the optimized circuit.

$f(A,B,C) = \Pi M(1,2,5,7,10,11,15)$

Sol: Given, $F(A,B,C,D) = \Pi M(1,2,5,7,10,11,15)$

AB \ CD	$C+D$ 00	$C+\bar{D}$ 01	$\bar{C}+\bar{D}$ 11	$\bar{C}+D$ 10
$A+B$ 00	0	0 1	3	0 2
$A+\bar{B}$ 01	4	0 5	0 7	6
$\bar{A}+\bar{B}$ 11	12	13	0 15	14
$\bar{A}+B$ 10	8	9	0 11	0 10

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

$B+\bar{C}+D$

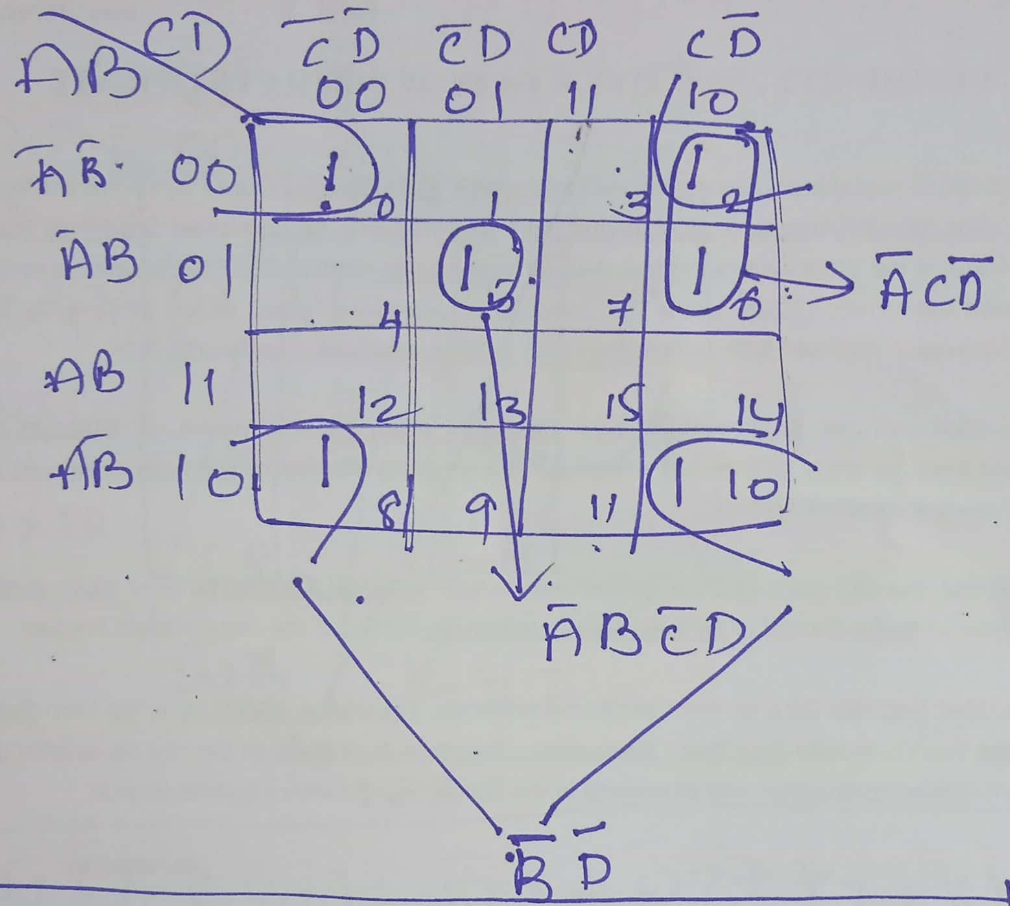
$A+C+\bar{D}$

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

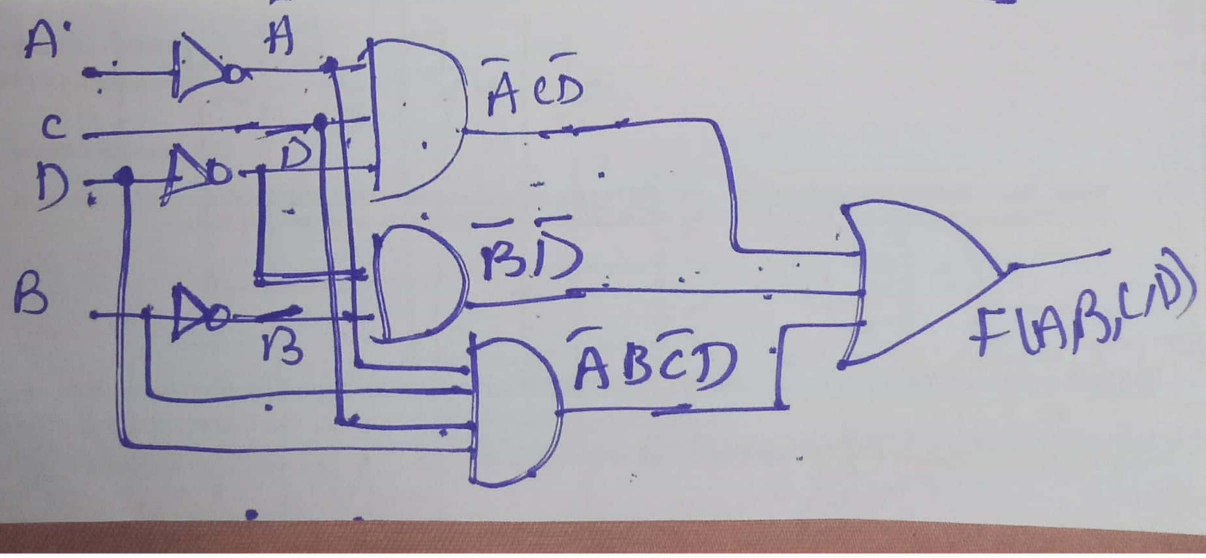
$$\boxed{f(A,B,C,D) = (A+C+\bar{D})(\bar{A}+\bar{C}+\bar{D})(\bar{B}+\bar{C}+\bar{D}) + B+\bar{C}+D}$$

5) Minimize the given SOP using K-Map and construct the optimized logic circuit. $F(A,B,C,D) = \Sigma m(0,2,5,6,8,10)$

Sol: Given, $F(A,B,C,D) = \Sigma m(0,2,5,6,8,10)$



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



(6)

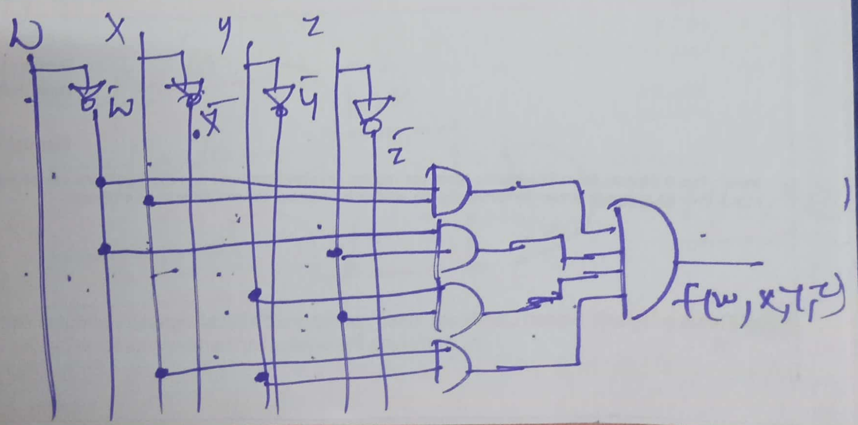
6. Optimize given function using K-map $f(w,x,y,z) = \Sigma m(1,3,4,5,6,7,11,14,15)$ and implement using logic gates.

Sol: Given, $f(w,x,y,z) = \Sigma m(1,3,4,5,6,7,11,14,15)$

$wx \backslash yz$	$\bar{y}\bar{z}$ 00	$\bar{y}z$ 01	yz 11	$y\bar{z}$ 10
$\bar{w}\bar{x}$ 00	0	1 (1)	1 (3)	2
$\bar{w}x$ 01	1 (4)	1 (5)	1 (7)	1 (6)
wx 11	12	13	1 (15)	1 (14)
$w\bar{x}$ 10	8	9	1 (11)	10

$\bar{w}x$ $\quad \bar{w}z$ $\quad yz$ $\quad xy$

$$\boxed{f(w,x,y,z) = \bar{w}x + \bar{w}z + yz + xy}$$



7. Optimize 4-variable function

$F(w,x,y,z) = \Sigma m(1,3,7,11,15) + d(0,2,5)$

using K-maps and realize minimized expression using K-maps.

<u>Sol</u>: Given, $F(w,x,y,z) = \Sigma m(1,3,7,11,15) + d(0,2,5)$

$wx \backslash yz$	$\bar{y}\bar{z}$ 00	$\bar{y}z$ 01	yz 11	$y\bar{z}$ 10
$\bar{w}\bar{x}$ 00	X 0	1 1	1 3	X 2
$\bar{w}x$ 01	4	X 5	1 7	6
wx 11	12	13	1 15	14
$w\bar{x}$ 10	8	9	1 11	10

$\rightarrow \bar{w}\bar{x}$

$\rightarrow yz$

$$\boxed{F(w,x,y,z) = \bar{w}\bar{x} + yz}$$