

ASSIGNMENT - 1A

(iii) ①

1) Convert the following :

i) $(10110.0101)_2 = (?)_{10}$

→
$$= (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (1 \times 2^1) + (0 \times 2^0) + (0 \times 2^{-1}) + (1 \times 2^{-2}) + (0 \times 2^{-3}) + (1 \times 2^{-4})$$

$$= 16 + 0 + 4 + 2 + 0 + 0 + 0.25 + 0 + 0.0625$$

$$= 22.3125$$

$\therefore (10110.0101)_2 = (22.3125)_{10}$

ii) $(DADA.B)_{16} = (?)_{10}$

→
$$= (D \times 16^3) + (A \times 16^2) + (D \times 16^1) + (A \times 16^0) + (B \times 16^{-1})$$

$$= (13 \times 16^3) + (10 \times 16^2) + (13 \times 16^1) + (10 \times 16^0) + (11 \times 16^{-1})$$

$$= 53248 + 2560 + 208 + 10 + 0.6875$$

$$= 56026.6875$$

$\therefore (DADA.B)_{16} = (56026.6875)_{10}$

PRO

iii) $(7562.45)_{10} = (?)_8$

8	7562	
8	945	- 2
8	118	- 1
8	14	- 6
8	1	- 6

16612

Now the fractional part:

$0.45 \times 8 = 3.6$

$0.6 \times 8 = 4.8$

$0.8 \times 8 = 6.4$

$0.4 \times 8 = 3.2$

$0.2 \times 8 = 1.6$

Now by taking only integer part,
the final conversion:

$(7562.45)_{10} = (16612.34631)_8$

iv) $(26.24)_{10} = (?)_8$

$$2 \times 8^1 + 6 \times 8^0 + 2 \times 8^{-1} + 4 \times 8^{-2}$$

$$= 2 \times 8 + 6 \times 1 + 2 \times 0.125 + 4 \times 0.015625$$

$$= 16 + 6 + 0.25 + 0.0625$$

$$= 22.3125$$

$\therefore (26.24)_{10} = (22.3125)_8$

v)
→

$(175.25)_{10} = (?)_2$

2	175	—	1
2	87	—	1
2	43	—	1
2	21	—	1
2	10	—	0
2	5	—	1
2	2	—	0
	1		

$\Rightarrow 10101111$

2	0.25	—	0
2	0.5	—	0
2	1.0	—	1
2	2.0	—	0
2	4.0	—	0
2	8.0	—	0
2	16.0	—	0
2	32.0	—	0
2	64.0	—	0
2	128.0	—	0
2	256.0	—	0
2	512.0	—	0
2	1024.0	—	0
2	2048.0	—	0
2	4096.0	—	0
2	8192.0	—	0
2	16384.0	—	0
2	32768.0	—	0
2	65536.0	—	0
2	131072.0	—	0
2	262144.0	—	0
2	524288.0	—	0
2	1048576.0	—	0
2	2097152.0	—	0
2	4194304.0	—	0
2	8388608.0	—	0
2	16777216.0	—	0
2	33554432.0	—	0
2	67108864.0	—	0
2	134217728.0	—	0
2	268435456.0	—	0
2	536870912.0	—	0
2	1073741824.0	—	0
2	2147483648.0	—	0
2	4294967296.0	—	0
2	8589934592.0	—	0
2	17179869184.0	—	0
2	34359738368.0	—	0
2	68719476736.0	—	0
2	137438953472.0	—	0
2	274877906944.0	—	0
2	549755813888.0	—	0
2	1099511627776.0	—	0
2	2199023255552.0	—	0
2	4398046511104.0	—	0
2	8796093022208.0	—	0
2	17592186044416.0	—	0
2	35184372088832.0	—	0
2	70368744177664.0	—	0
2	140737488355328.0	—	0
2	281474976710656.0	—	0
2	562949953421312.0	—	0
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2	20086725553032578444274526154264527823034391553445593088.0	—	0
2	40173451106065156888549052308529055646068783106891186176.0	—	0
2	80346902212130313777098104617058111292137566213782372352.0		

8	516002
8	64500 — 2
8	8062 — 4
8	1007 — 6
8	125 — 7
8	15 — 1510101
	1 — 7

⇒ 1757642

1	271	c
1	58	c
1	50	c
1	10	c
1	2	c
0	c	c
	1	

Now fractional part:

$$\begin{aligned}
 0.736572265625 \times 8 &= \textcircled{5}.89258 \\
 0.89258 \times 8 &= \textcircled{7}.14063 \\
 0.14063 \times 8 &= \textcircled{1}.125 \\
 0.125 \times 8 &= \textcircled{1}.0
 \end{aligned}$$

∴ final conversion:

$$(7DFA2.BC9)_{16} = (1757642.5711)_8$$

$$\begin{aligned}
 \text{ii) } (1757642.5711)_8 &= (?)_{10} \\
 &= 1 \times 8^6 + 7 \times 8^5 + 5 \times 8^4 + 7 \times 8^3 + 6 \times 8^2 + 4 \times 8^1 + 2 \times 8^0 + \\
 &\quad 5 \times 8^{-1} + 7 \times 8^{-2} + 1 \times 8^{-3} + 1 \times 8^{-4} \\
 &= 1 \times 262144 + 7 \times 32768 + 5 \times 4096 + 7 \times 512 + 6 \times 64 + 4 \times 8 \\
 &\quad + 2 \times 1 + 5 \times 0.125 + 7 \times 0.015625 + 1 \times 0.001953125 + \\
 &\quad 1 \times 0.000244140625 \\
 &= 516002.736572265625 \\
 \therefore (1757642.5711)_8 &= (516002.736572265625)_{10}
 \end{aligned}$$

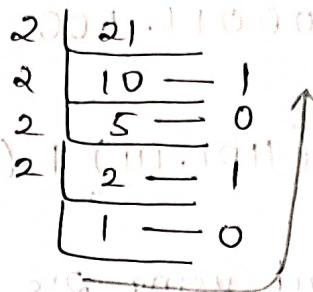
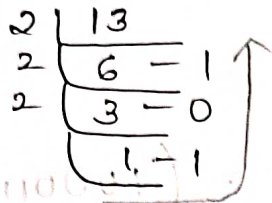
2) Perform the arithmetic operation in binary

I) Add

i) $(13.875)_2 + (21.625)_2$

→

A ⇒



1101

$0.875 \times 2 = 1.75 \rightarrow 1$
 $0.75 \times 2 = 1.5 \rightarrow 1$
 $0.5 \times 2 = 1.0 \rightarrow 1$

A ⇒ 1101.111

B ⇒ 10101

$0.625 \times 2 = 1.25 \rightarrow 1$
 $0.25 \times 2 = 0.5 \rightarrow 0$
 $0.5 \times 2 = 1.0 \rightarrow 1$

A = 1101.111

∴ B = 10101.101

$A + B = 01101.111$
 $+ 10101.101$

 100011.100

∴ $A + B = (100011.100)_2$

ii)

$(1101.111) + (10101.101)$

$$\begin{array}{r} 01101.111 \\ + 10101.101 \\ \hline 100011.100 \end{array}$$

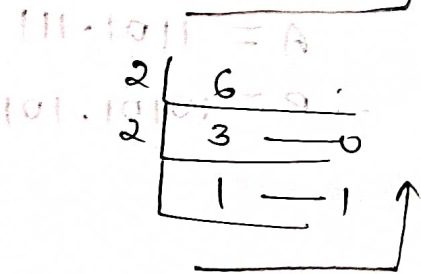
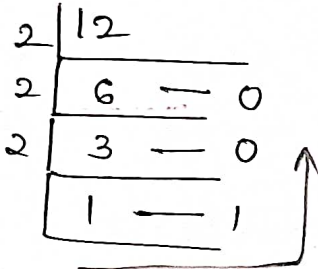
$\therefore (1101.111)_2 + (10101.101)_2 = (100011.100)_2$

ii)

Subtract using 2's complement method

i)

$12.875 - 6.375$



$\therefore A = 1100.111$

$B = 0110.011$

2's complement of $(B) = 1001.1001$

1's complement of B $\rightarrow 1001.100$

$$\begin{array}{r} + \quad \quad \quad 1 \\ \hline 1001.100 \\ \hline 1001.101 \end{array}$$

$0.875 \times 2 = 1.75 \rightarrow 1$
 $0.75 \times 2 = 1.5 \rightarrow 1$
 $0.5 \times 2 = 1.0 \rightarrow 1$

$0.375 \times 2 = 0.75 \rightarrow 0$
 $0.75 \times 2 = 1.5 \rightarrow 1$
 $0.5 \times 2 = 1.0 \rightarrow 1$

$$\begin{array}{r} 111.10110 \\ + 101.10101 \\ \hline 001.110001 \end{array}$$

Now 2's of B + A \Rightarrow

$$\begin{array}{r} 1001.101 \\ + 1100.111 \\ \hline 0110.100 \end{array}$$

$\therefore (0110.100)_2$

ii)

57 - 36

\rightarrow

A \Rightarrow

2	57
2	28 - 1
2	14 - 0
2	7 - 0
2	3 - 1
	1 - 1

B \Rightarrow

2	36
2	18 - 0
2	9 - 0
2	4 - 1
2	2 - 0
	1 - 0

$\therefore A = 111001$

$B = 100100$

1's of B = 011011

2's of B = 011011

$$\begin{array}{r} 011011 \\ + 111 \\ \hline 011100 \end{array}$$

Now 2's of B + A \Rightarrow

$$\begin{array}{r} 011100 \\ + 111001 \\ \hline 010101 \end{array}$$

$\therefore (010101)_2$

Now 2's of B + A \Rightarrow

$$\begin{array}{r} 000001 \\ + 010010 \\ \hline 010011 \end{array}$$

borrowing from 1's place

to convert 2's place

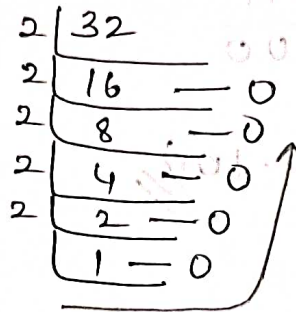
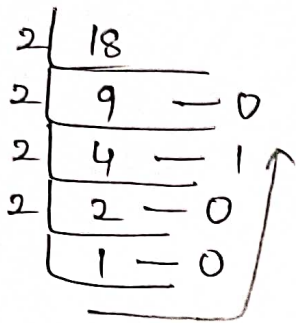
$$\begin{array}{r} 101100 \\ + 111 \\ \hline 011100 \end{array}$$

$\therefore (011100)_2$

iii) 8)

→

18-32



A = 10010

B = 100000

1's of B = 011111

2's of B = 011111

$$\begin{array}{r} 011111 \\ + 011111 \\ \hline 100000 \end{array}$$

Now 2's of B + A =

$$\begin{array}{r} 100000 \\ + 010010 \\ \hline 110010 \end{array}$$

Carry is not generated

∴ take 2's complement of (110010)

$$\Rightarrow \begin{array}{r} 001101 \\ + \quad \quad 11 \\ \hline 001110 \end{array}$$

∴ (001110)₂

∴ A + B to give 101010

101.1001

111.0011 +

001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

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001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

110.1101

001.0110

iii) $(\overline{A+B}) \cdot (\overline{\overline{A} + \overline{B}})$ (10.1010) \cdot (11.01101) (B V)

→

$\overline{A} \cdot \overline{B} \cdot \overline{\overline{A}} \cdot \overline{\overline{B}}$ [∵ Demorgan's law] 11.01101 = A
10.10110 = B

$\overline{A} \cdot \overline{B} \cdot A \cdot B$ (∵ A to 2's
B to 2's)

$A \cdot \overline{A} \cdot \overline{B} \cdot B$ [∵ Inverse law] 01 = B to 2's

$= 0$ $A\overline{A} = 0$

iv)

$\overline{a}bc + a\overline{b}c + abc + \overline{a}b\overline{c}$

$= \overline{a}bc + abc + a\overline{b}c + \overline{a}b\overline{c}$

$= bc(a + \overline{a}) + a\overline{b}c + \overline{a}b\overline{c}$

$= bc + a\overline{b}c + \overline{a}b\overline{c}$ [inverse law $(a + \overline{a}) = 1$] (10.1001001)

$= b[c + a\overline{c} + \overline{a}c]$ 01.10010

$= b[c + \overline{c}(a + \overline{a})]$ [∵ Inverse law] (B)

$= b[c + \overline{c}]$ [∵ inverse law] (i)

$= b$

v)

→

$(\overline{x+y}) \cdot (\overline{\overline{x} + \overline{y}})$ [∵ $0 = \overline{1}$] (ii)

$\overline{x} \cdot \overline{y} \cdot (\overline{\overline{x} + \overline{y}})$

$\overline{x} \cdot \overline{y} + \overline{x} \cdot \overline{y}$ ABC + \overline{A}B + A\overline{B}

$\overline{x} \cdot \overline{y}$ [∵ Independent law] = ABC + \overline{A}B + A\overline{B} =

$\overline{x} \cdot \overline{y} = (\overline{x+y})$ [∵ inverse law] = AB(C+\overline{C}) + \overline{A}B =

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

$= \overline{A}B$ [∵ inverse law]

vi) $(x+y) \cdot (x+\bar{y}) + \overline{(\bar{x}\bar{y}) + \bar{x}}$

→ $xx + x\bar{y} + xy + y\bar{y} + \bar{x}\bar{y} + \bar{x}$

$x + x\bar{y} + xy + \bar{x}\bar{y} + \bar{x}$ [∵ inverse law $y \cdot \bar{y} = 0$]

$x + \bar{x} + x\bar{y} + xy + x\bar{y}$

$1 + x\bar{y} + xy + x\bar{y}$ [∵ inverse law $x + \bar{x} = 1$]

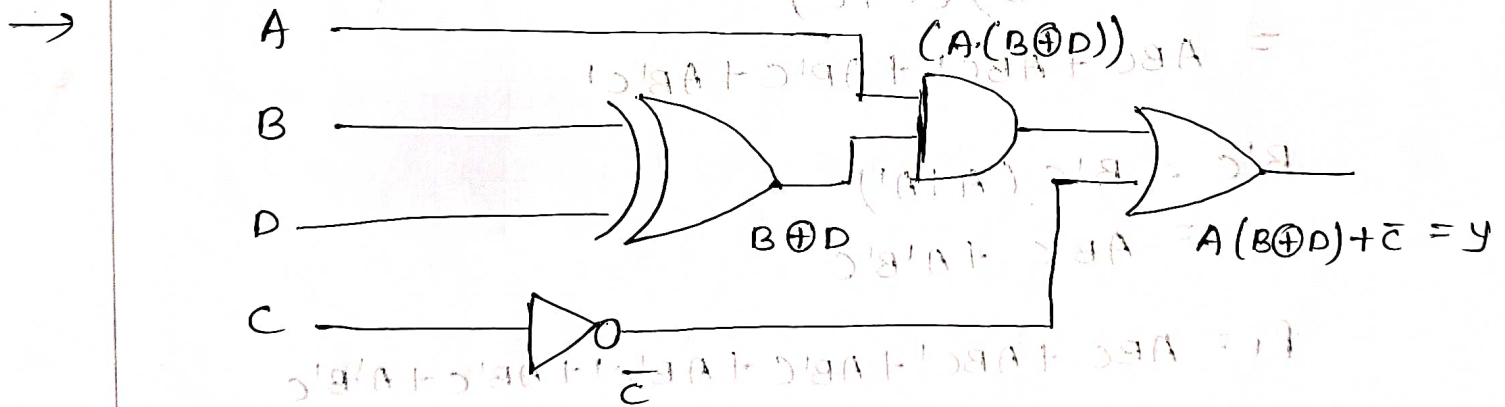
$1 + x\bar{y} + xy$ [∵ independent law $x\bar{y} + x\bar{y} = x\bar{y}$]

$= 1 + x(y + \bar{y})$

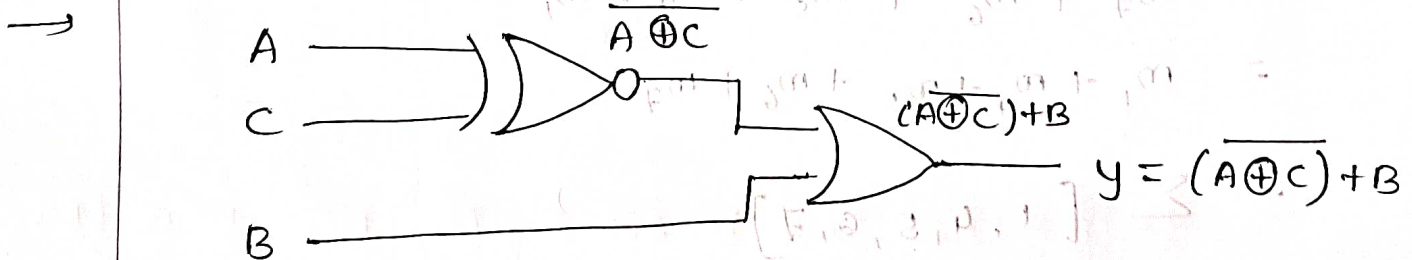
$= 1 + x$ [∵ $y + \bar{y} = 1$]

4) Draw the logic diagram from the given logic function.

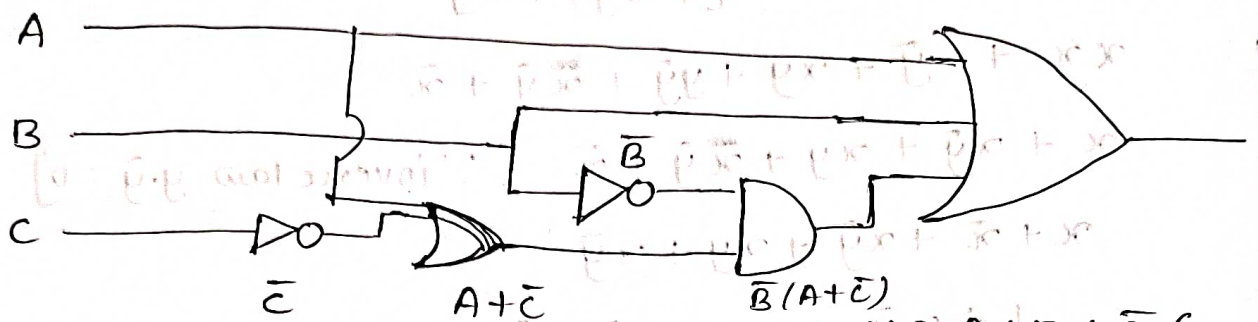
i) $A(B \oplus D) + \bar{C}$



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



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



5) Express the following in sum of min-term and product of max term.

i) $f_1 = A + \bar{B}C$

Sum of minterm

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

$A = A \cdot 1$

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

$= (AB + AB') \cdot (C + C')$

$= ABC + ABC' + AB'C + AB'C'$

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

$= AB'C + A'B'C$

$f_1 = ABC + ABC' + AB'C + AB'C' + AB'C + A'B'C$

$= ABC + ABC' + AB'C + AB'C' + A'B'C$

$= m_7 + m_6 + m_5 + m_4 + m_1$

$= m_1 + m_4 + m_5 + m_6 + m_7$

$\sum [1, 4, 5, 6, 7]$

Product of maxterm

$$F_1 = A + \bar{B}C$$

$$F_1 = (A + \bar{B})(A + C) \quad [\therefore \text{distributive law}]$$

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

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

$$f_1 = (A + \bar{B} + C) \cdot (A + \bar{B} + \bar{C}) \cdot (A + B + C) \cdot (A + \bar{B} + C)$$

$$= \begin{matrix} 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \end{matrix}$$

$$= M_2 \cdot M_3 \cdot M_0 \cdot M_2$$

$$= M_0 \cdot M_2 \cdot M_3$$

$$= \Pi [0, 2, 3]$$

ii)

$$f = xy + \bar{x}z$$

sum of minterm

$$f = xy + \bar{x}z$$

$$xy = xy(z + \bar{z})$$

$$= xyz + xy\bar{z}$$

$$\bar{x}z = \bar{x}z(y + \bar{y})$$

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

$$f = xyz + xy\bar{z} + \bar{x}yz + \bar{x}\bar{y}z$$

$$= m_7 + m_6 + m_3 + m_1$$

$$= m_1 + m_3 + m_6 + m_7$$

$$\therefore f = \sum [1, 3, 6, 7]$$

product of maxterm

$$F = xy + \bar{x}z$$

$$= [xy + \bar{x}] [xy + z]$$

$$= [x + \bar{x}] [\bar{x} + y] [x + z] [z + y]$$

$$= 1 (\bar{x} + y) (x + z) (z + y)$$

$$\bar{x} + y + (z\bar{z}) = (\bar{x} + y + z) (\bar{x} + y + \bar{z})$$

$$x + z + y\bar{y} = (x + y + z) (x + \bar{y} + z)$$

$$z + y + x\bar{x} = (x + y + z) (\bar{x} + y + z)$$

$$F = (\bar{x} + y + z) \cdot (\bar{x} + y + \bar{z}) (x + y + z) (x + \bar{y} + z)$$

$$\begin{matrix} 1 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \end{matrix}$$

$$= m_4 \cdot m_5 \cdot m_0 \cdot m_2$$

$$= m_0 \cdot m_2 \cdot m_4 \cdot m_5$$

$$= \Pi [0, 2, 4, 5]$$

6) Convert each of the following expressions into SOP and POS

i) $(AB + C)(B + \bar{C}\bar{D})$

SOP!

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

$$= A \cdot BB + AB\bar{C}\bar{D} + BC + C\bar{C}\bar{D}$$

$$= AB + AB\bar{C}\bar{D} + BC + 0$$

$$= ABC(C + \bar{C}) + AB\bar{C}\bar{D} + (A + \bar{A})BC$$

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

$$= ABC(D + \bar{D}) + AB\bar{C}(D + \bar{D}) + AB\bar{C}\bar{D} + ABC(D + \bar{D}) + \bar{A}BC(D + \bar{D})$$

$$= ABCD + ABC\bar{D} + AB\bar{C}D + AB\bar{C}\bar{D} + AB\bar{C}\bar{D} + ABCD + ABC\bar{D} + \bar{A}BCD + \bar{A}BC\bar{D}$$

$$= ABCD + \bar{A}BCD + ABC\bar{D} + AB\bar{C}D + AB\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} \quad (11)$$

1111	0111	1110	1101	1100	0110
↓	↓	↓	↓	↓	↓
15	7	14	13	12	6

$$F(A, B, C, D) = \sum (6, 7, 12, 13, 14, 15)$$

$$= \sum (m_6, m_7, m_{12}, m_{13}, m_{14}, m_{15})$$

Pos : $F = (A+B+C) \cdot (B+\bar{C}\bar{D}) + \dots$

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

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

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

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

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

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

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

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

$$(\overset{0}{A} + \overset{0}{B} + \overset{1}{\bar{C}} + \overset{0}{D})(\overset{0}{A} + \overset{0}{B} + \overset{1}{\bar{C}} + \overset{1}{\bar{D}})(\overset{1}{\bar{A}} + \overset{0}{B} + \overset{1}{\bar{C}} + \overset{0}{D})(\overset{1}{\bar{A}} + \overset{0}{B} + \overset{1}{\bar{C}} + \overset{1}{\bar{D}})$$

$$(\overset{1}{\bar{A}} + \overset{0}{B} + \overset{0}{C} + \overset{1}{\bar{D}})$$

$$= \prod (0, 1, 2, 3, 4, 5, 9, 10, 11) \quad (m)$$

$$F = \prod (m_0, m_1, m_2, m_3, m_4, m_5, m_9, m_{10}, m_{11})$$

ii) ~~f(x,y,z)~~ $\bar{x} + x(x + \bar{y})(y + \bar{z})$

→ SOP

$$= \bar{x} + (x \cdot x + x \cdot \bar{y}) (y + \bar{z})$$

$$= \bar{x} + (x + x\bar{y}) (y + \bar{z})$$

$$= \bar{x} + x(y + \bar{z}) + \bar{x}\bar{y}(y + \bar{z})$$

$$= \bar{x} + (xy + x\bar{z}) + (\bar{x}\bar{y}y + \bar{x}\bar{y}\bar{z})$$

$$= \bar{x} + xy + x\bar{z} + 0 + \bar{x}\bar{y}\bar{z}$$

$$= \bar{x}(y + \bar{y}) + xy(z + \bar{z}) + x\bar{z}(y + \bar{y}) + \bar{x}\bar{y}\bar{z}$$

$$= \bar{x}y + \bar{x}\bar{y} + xy\bar{z} + xy\bar{z} + x\bar{z}y + x\bar{z}\bar{y} + \bar{x}\bar{y}\bar{z}$$

$$= \bar{x}y(z + \bar{z}) + \bar{x}\bar{y}(z + \bar{z}) + xy\bar{z} + x\bar{z}y + x\bar{z}\bar{y} + \bar{x}\bar{y}\bar{z}$$

$$= \bar{x}y\bar{z} + \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$= \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$= \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$= \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$= \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$= \bar{x}y\bar{z} + \bar{x}\bar{y}\bar{z} + xy\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}\bar{z} + x\bar{z}y + x\bar{z}\bar{y}$$

$$f(x,y,z) = \sum (0, 1, 2, 3, 4, 6, 7)$$

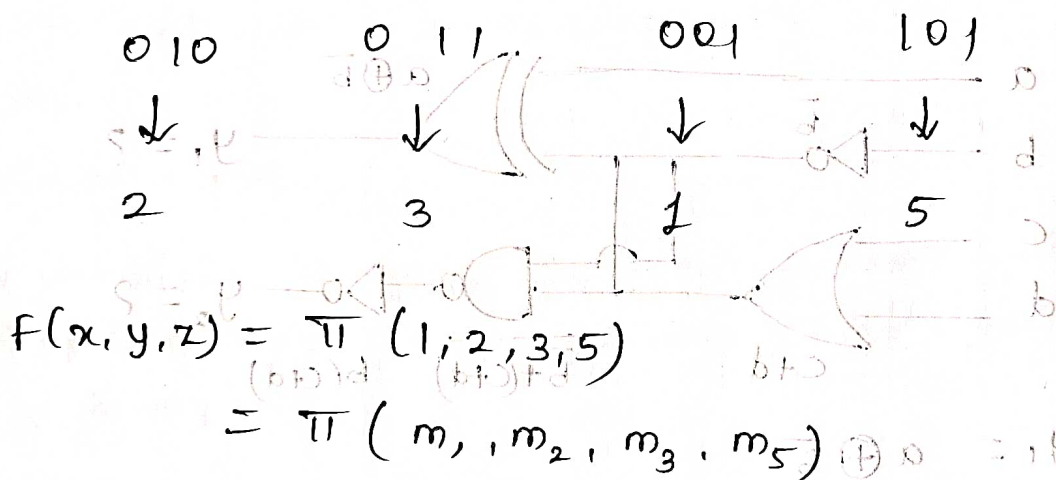
$$= \sum (m_0, m_1, m_2, m_3, m_4, m_6, m_7)$$

$$= \sum (m_0, m_1, m_2, m_3, m_4, m_6, m_7)$$

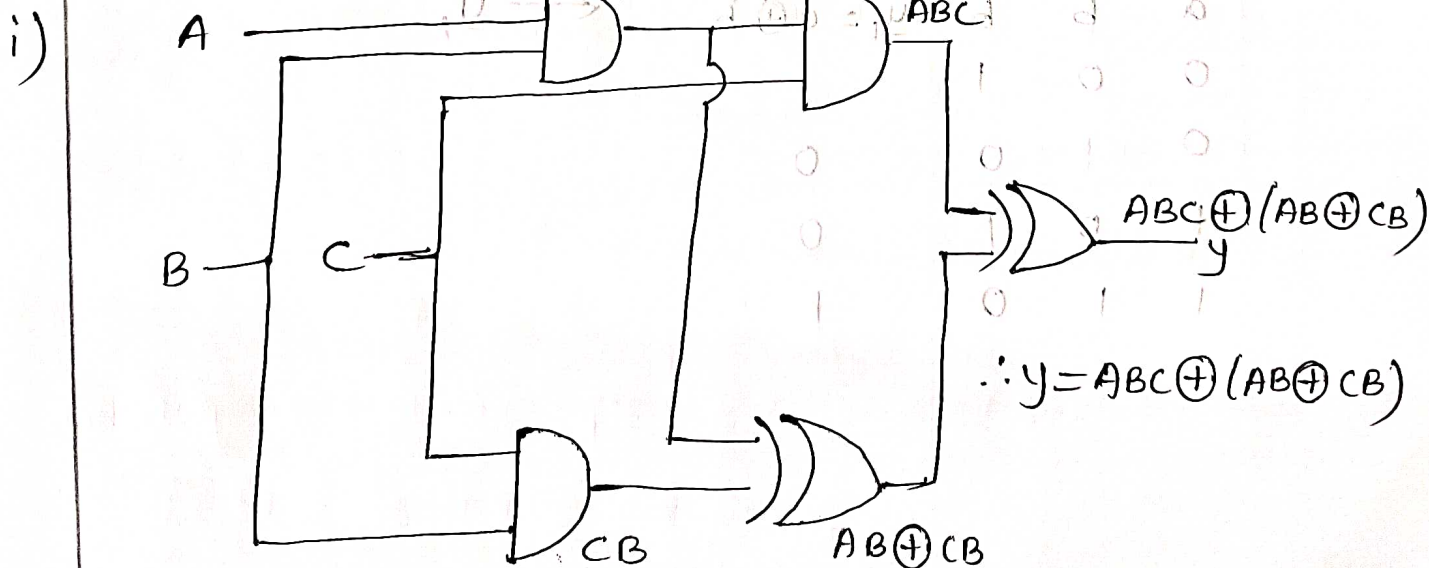
$$= \sum (m_0, m_1, m_2, m_3, m_4, m_6, m_7)$$

POS :

$$\begin{aligned}
 F &= \bar{x} + x(\bar{x} + \bar{y})(y + \bar{z}) \\
 &= \bar{x} + (x\bar{x} + x\bar{y})(y + \bar{z}) \\
 &= (\bar{x} + x)(\bar{x} + \bar{y})(y + \bar{z}) \\
 &= \bar{x} + (x + x)(\bar{x} + \bar{y})(y + \bar{z}) \\
 &= (\bar{x} + x)(\bar{x} + \bar{y})(y + \bar{z}) \\
 &= 1(\bar{x} + \bar{y})(y + \bar{z}) \\
 &= (\bar{x} + \bar{y} + z\bar{z})(\bar{x}\bar{x} + y + \bar{z}) \\
 &= (\bar{x} + \bar{y} + z)(\bar{x} + \bar{y} + \bar{z})(\bar{x} + y + \bar{z})(\bar{x} + y + \bar{z})
 \end{aligned}$$



7) Write the output expression and construct the truth table from the given logic circuit.

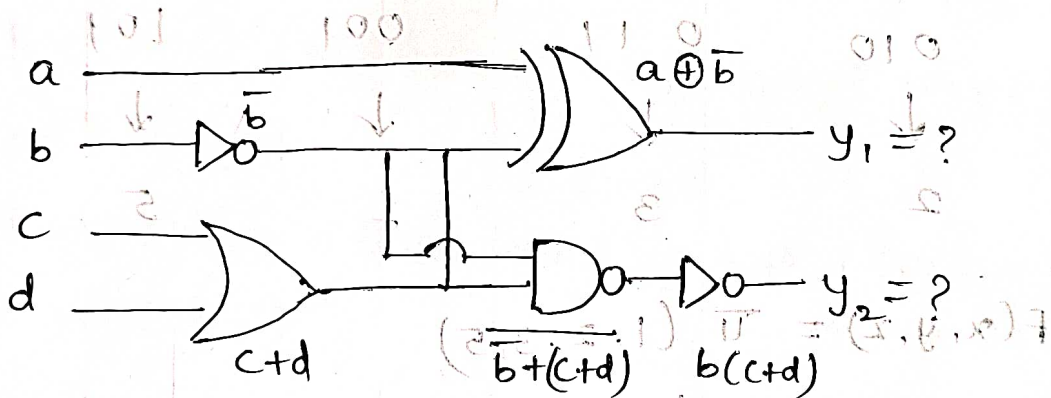


Truth table:

$$Y = ABC \oplus (AB \oplus CB)$$

Input			Intermediate				Output
A	B	C	AB	CB	ABC	$AB \oplus CB$	$ABC \oplus (AB \oplus CB)$
0	0	0	0	0	0	0	0
0	0	1	0	0	0	0	0
0	1	0	0	0	0	0	0
0	1	1	0	1	0	1	1
1	0	0	0	0	0	0	0
1	0	1	0	0	0	0	0
1	1	0	1	0	0	1	1
1	1	1	1	1	1	0	1

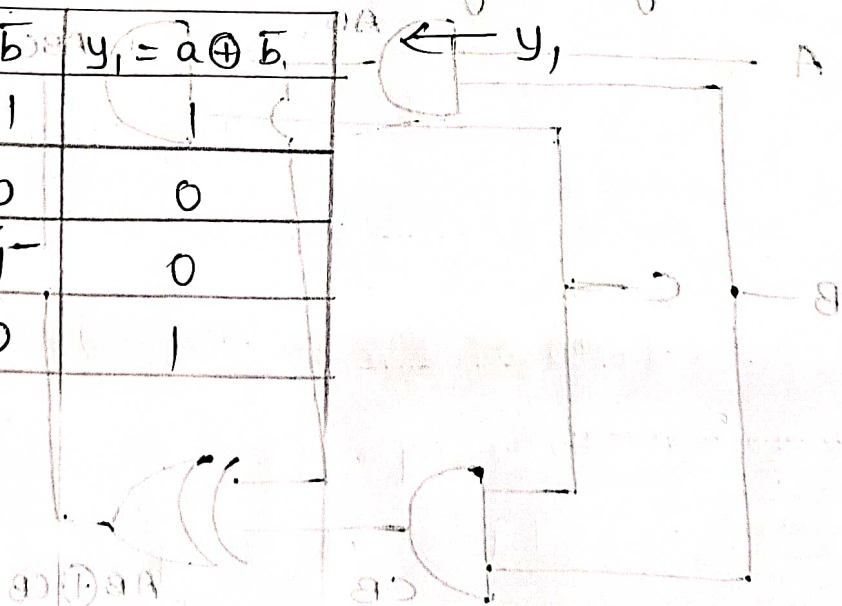
ii)



$$y_1 = a \oplus \bar{b}$$

$$y_2 = b(c+d)$$

a	b	\bar{b}	$y_1 = a \oplus \bar{b}$
0	0	1	1
0	1	0	0
1	0	1	0
1	1	0	1



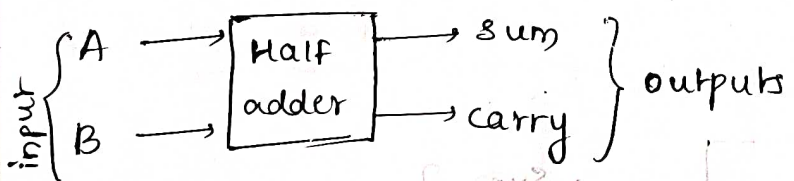
b	c	d	c+d	$y_2 = b(c+d)$
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	0	0
1	0	1	1	1
1	1	0	1	1
1	1	1	1	1

8) Design half adder and full adder and realize using logic gates.

i) half adder:

A combinational circuit that perform addition of two bits. These circuits needs two binary inputs and two binary outputs.

Symbol:



Truth table:

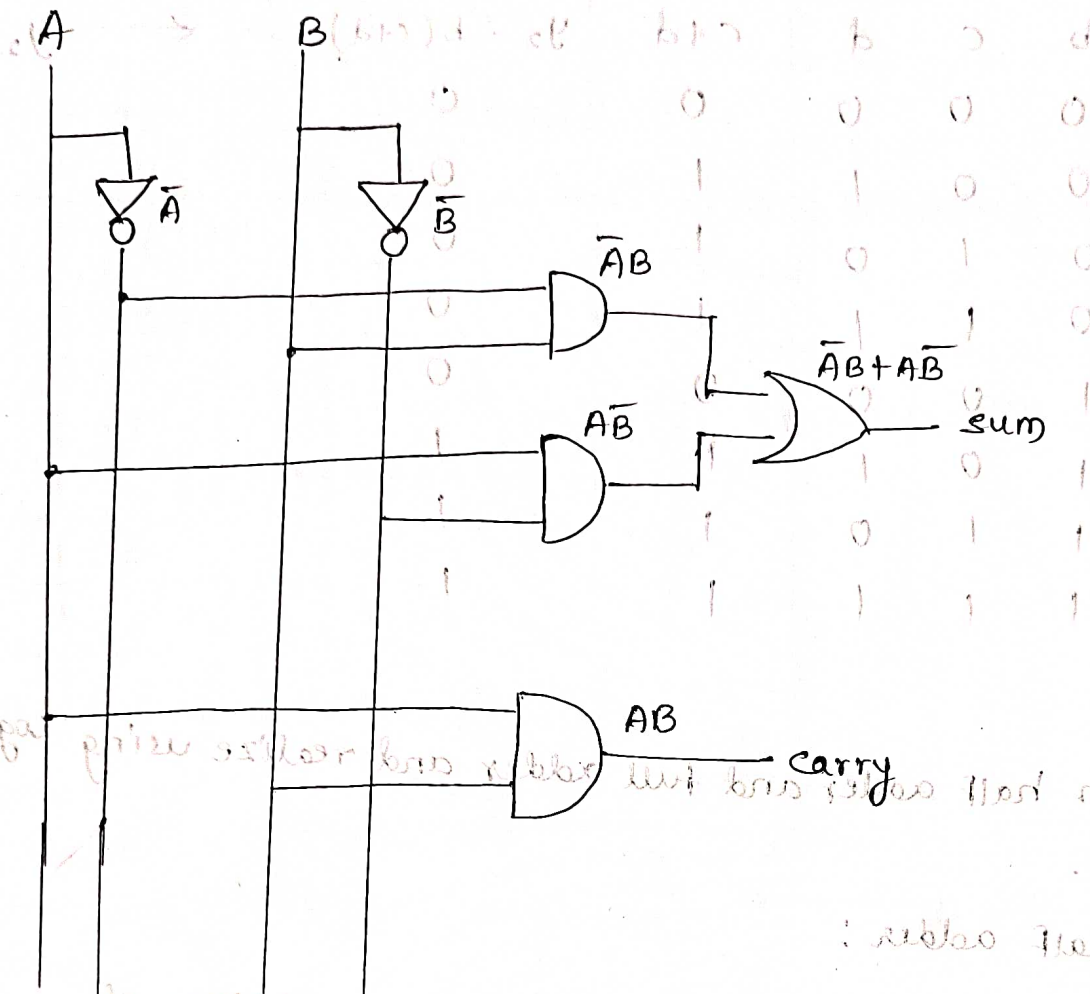
A	B	sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Boolean expression:

$$\text{Sum} = \bar{A}B + A\bar{B} = A \oplus B$$

$$\text{Carry} = AB$$

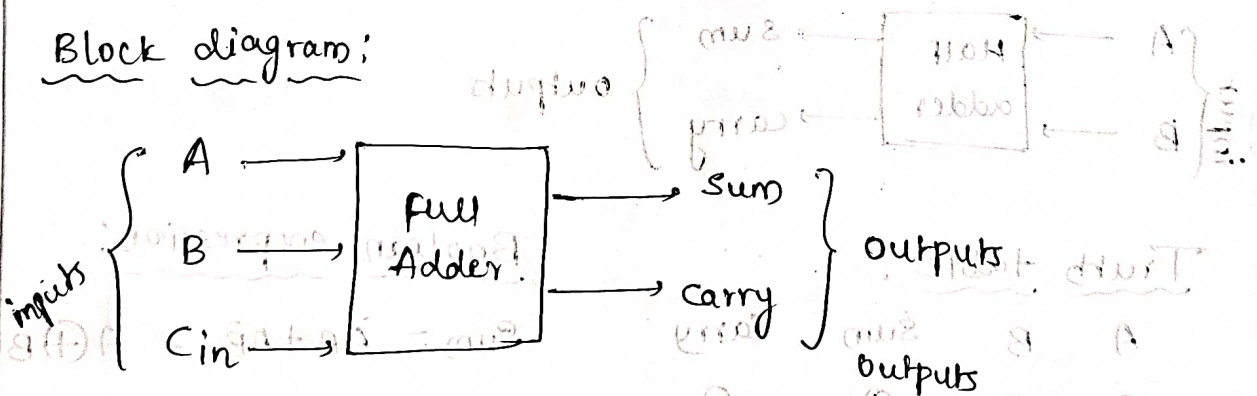
Logic diagram:



ii) Full Adder:

A full adder is a combinational circuit that performs the arithmetic sum of three input bits (two significant bits and a carry from previous state).

Block diagram:



- * It consists of three inputs and two outputs.
- * Two input variables A & B represents the two significant bits to be added.
- * Third input Cin represents the carry from the previous lower significant position.

Truth table :

A	B	C _{in}	Sum	Carry
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

Boolean expression:

$$\text{Sum} = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$\text{Carry} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$

After implementing basic gates,

$$\text{sum} = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}$$

$$\text{Carry} = AB + BC_{in} + AC_{in}$$

Logic diagram:

