ASSIGNMENT – 1A

1) Convert the following :

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

→ $= (1\times2^4)+(0\times2^3)+(1\times2^2)+(1\times2^1)+(0\times2^0)+(0\times2^{-1})+(1\times2^{-2})+(0\times2^{-3})+(1\times2^{-4})$

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

$= 22.3125$

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

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

→ $= (D\times16^3)+(A\times16^2)+(D\times16^1)+(A\times16^0)+(B\times16^{-1})$

$= (13\times16^3)+(10\times16^2)+(13\times16^1)+(10\times16^0)+(11\times16^{-1})$

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

$= 56026.6875$

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

PTO

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

$\rightarrow$

$$
\begin{array}{r|l l}
8 & 7562 & \\
8 & 945 & - 2 \\
8 & 118 & - 1 \\
8 & 14 & - 6 \\
8 & 1 & - 6 \\
  &   & \uparrow
\end{array}
\qquad 16612
$$

Now the fractional part:

$0.45 \times 8 = 3.6$

$0.6 \times 8 = 4.8$

$0.8 \times 8 = 6.4$ $\qquad 0.34631$

$0.4 \times 8 = 3.2$

$0.2 \times 8 = 1.6$ $\downarrow$

Now by taking only integer ~~part~~ part, the final conversion:

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

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

$\rightarrow$

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

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

$= 16 + 6 + 0.25 + 0.0625$

$= 22.3125$

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

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

→

$$
\begin{array}{r|l}
2 & 175 - 1 \\
2 & 87 - 1 \\
2 & 43 - 1 \\
2 & 21 - 1 \\
2 & 10 - 0 \\
2 & 5 - 1 \\
2 & 2 - 0 \\
  & 1
\end{array}
\Rightarrow 10101111
$$

Now fractional part:

$0.25 \times 2 = 0.5$

$0.5 \times 2 = 1.0$

$\Rightarrow 0.01$

Now final conversion becomes

$(175.25)_{10} = (10101111.01)_2$

vi) $(7DFA2.BC9)_{16} = (?)_8 = (?)_{10}$

→ i) $(7DFA2.BC9)_{16} = (?)_8$

→ Let us first convert the given hexadecimal number.

$7 \times 16^4 + 13 \times 16^3 + 15 \times 16^2 + 10 \times 16^1 + 2 \times 16^0 + 11 \times 16^{-1} + 12 \times 16^{-2} + 9 \times 16^{-3}$

$= 7 \times 65536 + 13 \times 4096 + 15 \times 256 + 10 \times 16 + 2 \times 1 + 11 \times 0.0625 +$

$12 \times 0.00390625 + 9 \times 0.000244140625$

$= (516002.736572265625)_{10}$

PTO

8	516002	
8	64500	— 2
8	8062	— 4
8	1007	— 6
8	125	— 7
8	15	— 5
	1	— 7

$\Rightarrow 1757642$

Now fractional part:

$0.736572265625 \times 8 = 5.89258$

$0.89258 \times 8 = 7.14063$

$0.14063 \times 8 = 1.125$

$0.125 \times 8 = 1.0$

$\Rightarrow 5711$

$\therefore$ final conversion:

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

ii) $(1757642.5711)_8 = (?)_{10}$

$= 1\times8^6 + 7\times8^5 + 5\times8^4 + 7\times8^3 + 6\times8^2 + 4\times8^1 + 2\times8^0 +$
$5\times8^{-1} + 7\times8^{-2} + 1\times8^{-3} + 1\times8^{-4}$

$= 1\times262144 + 7\times32768 + 5\times4096 + 7\times512 + 6\times64 + 4\times8$
$+ 2\times1 + 5\times0.125 + 7\times0.015625 + 1\times0.001953125 +$
1×0.000244140625

$= 516002.736572265625$

$\therefore (1757642.5711)_8 = (516002.736572265625)_{10}$

2) Perform the arithmetic operations in binary

I) Add

i) $(13.875)_{10} + (21.625)_{10}$

→ A ⇒

$$
\begin{array}{r|l}
2 & 13 \\
2 & 6 - 1 \\
2 & 3 - 0 \\
 & 1 - 1
\end{array}
\qquad
\begin{array}{r|l}
2 & 21 \\
2 & 10 - 1 \\
2 & 5 - 0 \\
2 & 2 - 1 \\
 & 1 - 0
\end{array}
$$

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

$$
\begin{array}{rr}
A+B = & 01101.111 \\
+ & 10101.101 \\
\hline
 & 100011.100
\end{array}
$$

∴ $A+B = (100011.100)_2$

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 compliment method

i) $12.875 - 6.375$

→

$$\begin{array}{r|l} 2 & 12 \\ \hline 2 & 6 - 0 \\ \hline 2 & 3 - 0 \\ \hline & 1 - 1 \end{array}$$

$0.875 \times 2 = 1.75 \rightarrow 1$

$0.75 \times 2 = 1.5 \rightarrow 1$

$0.5 \times 2 = 1.0 \rightarrow 1$

$$\begin{array}{r|l} 2 & 6 \\ \hline 2 & 3 - 0 \\ \hline & 1 - 1 \end{array}$$

$0.375 \times 2 = 0.75 \rightarrow 0$

$0.75 \times 2 = 1.5 \rightarrow 1$

$0.5 \times 2 = 1.0 \rightarrow 1$

$\therefore A = 1100.111$

$B = 0110.011$

2's compliment of B :

1's compliment of B → 1001.100

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

Now 2's of B + A ⇒

$$\begin{array}{r} 1001.101 \\ +\ 1100.111 \\ \hline 1\,0110.100 \end{array}$$

∴ $(0110.100)_2$

ii) 57 - 36

A ⇒

$$\begin{array}{r|l} 2 & 57 \\ \hline 2 & 28 - 1 \\ 2 & 14 - 0 \\ 2 & 7 - 0 \\ 2 & 3 - 1 \\ & 1 - 1 \end{array}$$

B ⇒

$$\begin{array}{r|l} 2 & 36 \\ \hline 2 & 18 - 0 \\ 2 & 9 - 0 \\ 2 & 4 - 1 \\ 2 & 2 - 0 \\ & 1 - 0 \end{array}$$

∴ A = 111001

B = 100100

1's of B = 011011

2's of B = 011011

$$\begin{array}{r} 011011 \\ +\ \ \ \ \ \ 1 \\ \hline 011100 \end{array}$$

Now 2's of B + A ⇒

$$\begin{array}{r} 011100 \\ +\ 111001 \\ \hline 1\,010101 \end{array}$$

∴ $(010101)_2$

iii) 8) 18 − 32

→

2	18	
2	9	− 0
2	4	− 1
2	2	− 0
	1	− 0

2	32	
2	16	− 0
2	8	− 0
2	4	− 0
2	2	− 0
	1	− 0

A = 10010

B = 100000

1's of B = 011111

2's of B = 011111
$\quad$ + 1
$\quad$ 100000

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)

$$\Rightarrow \begin{array}{r} 001101 \\ +\ \ \ 1 \\ \hline 001110 \end{array}$$

∴ $(001110)_2$ //

iv a) $(10110.11) - (1101.01)$

$\rightarrow$ $A = 10110.11$

$B = 01101.01$

2's of B $\Rightarrow$

1's of B $= 10010.10$

$+ \quad 1$

10010.11

Now 2's of B + A

$= 10010.11$

$+ 10110.11$

$\textcircled{1}01001.10$

$\therefore 01001.10$

3) Simplify the following functions:

i) $(x+y)(x+\bar{y})$

$= x + y\bar{y}$ [$\because$ distributive law]

$= x$ [$\because y\bar{y} = 0$]

ii a) $ABC + \bar{A}B + AB\bar{C}$

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

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

$= AB + \bar{A}B$ [$\because (C+\bar{C}) = 1$] inverse law

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

$= B$ [$\because$ inverse law]

iii) $(\overline{A+B}).(\overline{\bar{A}+\bar{B}})$

$\rightarrow$ $\bar{A}\cdot\bar{B}\cdot\bar{\bar{A}}.\bar{\bar{B}}$ [$\because$ Demorgan's law]

$\bar{A}.\bar{B}.\ A\cdot B$

$A\cdot\bar{A}\cdot\bar{B}B$ [$\because$ Inverse law] $A\bar{A}=0$

$= 0$

iv) $\bar{a}bc + ab\bar{c} + abc + \bar{a}b\bar{c}$

$= \bar{a}bc + abc + ab\bar{c} + \bar{a}b\bar{c}$

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

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

$= b[c + a\bar{c} + \bar{a}\bar{c}]$

$= b[c + \bar{c}(a+\bar{a})]$ [$\because$ Inverse law]

$= b[c+\bar{c}]$ [$\because$ inverse law]

$= b$

v) $(\overline{x+y}).(\bar{x}+\bar{y})$

$\rightarrow$ $\bar{x}\cdot\bar{y}\cdot(\bar{x}+\bar{y})$

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

$\bar{x}\bar{y}$ [$\because$ Independent law]

6

vi) $(x+y)\cdot(x+\bar{y})+\left[\overline{(\bar{x}\bar{y})+\bar{x}}\right]$

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

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

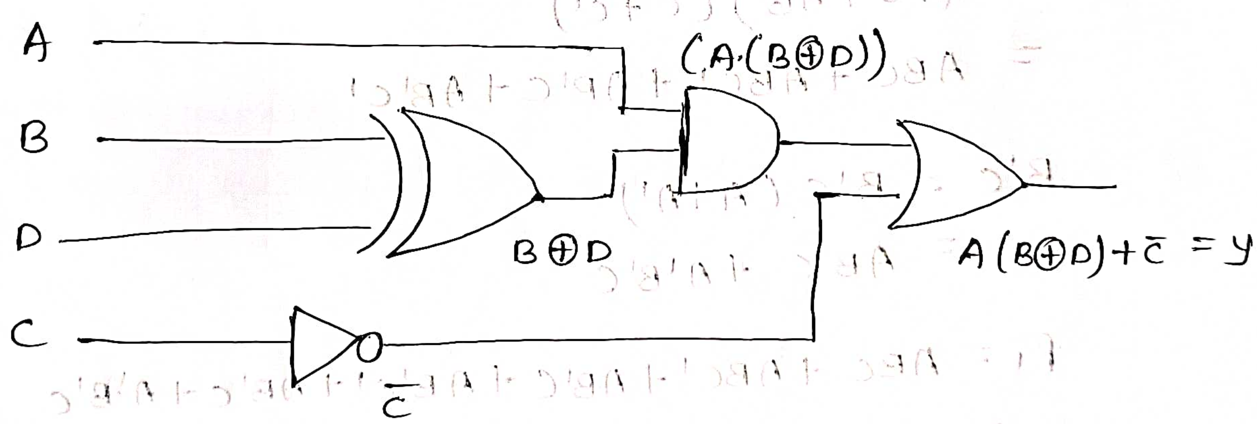
$=1+x(y+\bar{y})$

$=1+x$ [∵ $y+\bar{y}=1$]

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

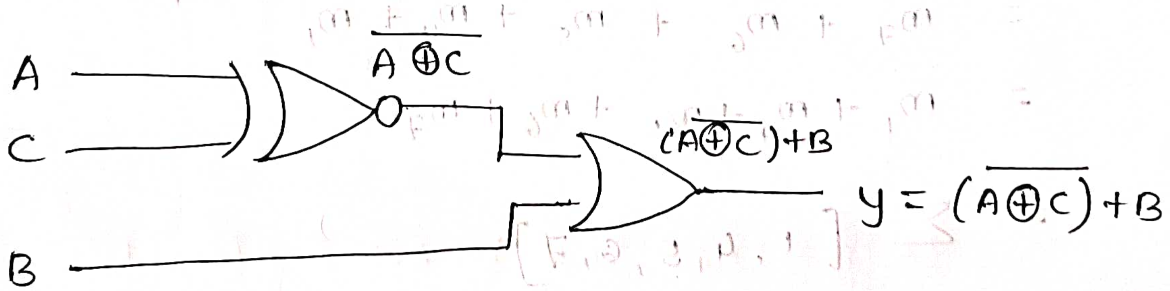
i) $A(B\oplus D)+\bar{C}$

$\rightarrow$

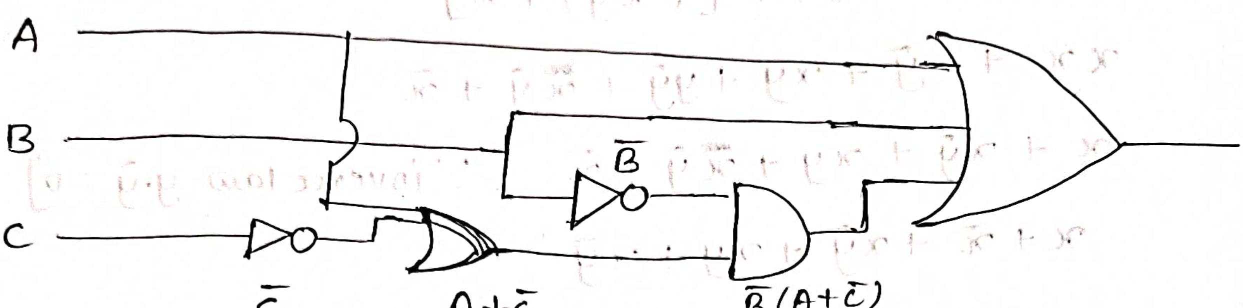


ii) $(\overline{A\oplus C})+B$

$\rightarrow$



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



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

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

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

Sum of minterm

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

$A = A \cdot 1$

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

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

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

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

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

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

$= \underset{111}{ABC} + \underset{110}{ABC'} + \underset{101}{AB'C} + \underset{100}{AB'C'} + \underset{001}{A'B'C}$

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

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

$= \Sigma[1,4,5,6,7]$

Product of maxterm

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

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

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

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

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

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

$F_1 = (A+\bar{B}+C)\cdot(A+\bar{B}+\bar{C})\cdot(A+B+C)\cdot(A+\bar{B}+C)$

$= \quad 0\ 1\ 0 \quad 0\ 1\ 1 \quad 0\ 0\ 0 \quad 0\ 1\ 0$

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

$= M_0 \cdot M_2 \cdot M_3$

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

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

→ sum of minterm

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

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

$= xyz + xy\bar{z}$

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

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

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

$= m_7 + m_6 + m_3 + m_1$

$= m_1 + m_3 + m_6 + m_7$

$\therefore F = \Sigma\,[1, 3, 6, 7]$

product of maxterm

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

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

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

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

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

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

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

$$F = \underset{1\ 0\ 0}{(\bar{x} + y + z)} \cdot \underset{1\ 0\ 1}{(\bar{x} + y + \bar{z})} \underset{0\ 0\ 0}{(x + y + z)} \underset{0\ 1\ 0}{(x + \bar{y} + z)}$$

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

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

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

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

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

SOP:

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

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

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

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

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

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

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

$+ \bar{A}BCD + \bar{A}BC\bar{D}$

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

$$\begin{array}{cccccc} 1111 & 0111 & 1110 & 1101 & 1100 & 0110 \\ \downarrow & \downarrow & \downarrow & \downarrow & \downarrow & \downarrow \\ 15 & 7 & 14 & 13 & 12 & 6 \end{array}$$

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

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

POS: $F = (AB+C)\cdot(B+\bar{C}\bar{D})$

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

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

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

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

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

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

$$= \Pi(0,1,2,3,4,5,9,10,11)$$

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

ii) $\cancel{f}\cdot\ \bar{x} + x(x+\bar{y})(y+\bar{z})$

→ **SOP :**

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

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

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

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

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

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

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

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

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

$= \underset{111}{xyz} + \underset{011}{\bar{x}yz} + \underset{110}{xy\bar{z}} + \underset{010}{\bar{x}y\bar{z}} + \underset{001}{\bar{x}\bar{y}z} + \underset{100}{x\bar{y}\bar{z}} + \underset{000}{\bar{x}\bar{y}\bar{z}}$

$\downarrow\ \ 7 \quad \downarrow\ \ 3 \quad \downarrow\ \ 6 \quad \downarrow\ \ 2 \quad \downarrow\ \ 1 \quad \downarrow\ \ 4 \quad \downarrow\ \ 0$

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

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

POS :

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

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

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

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

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

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

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

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

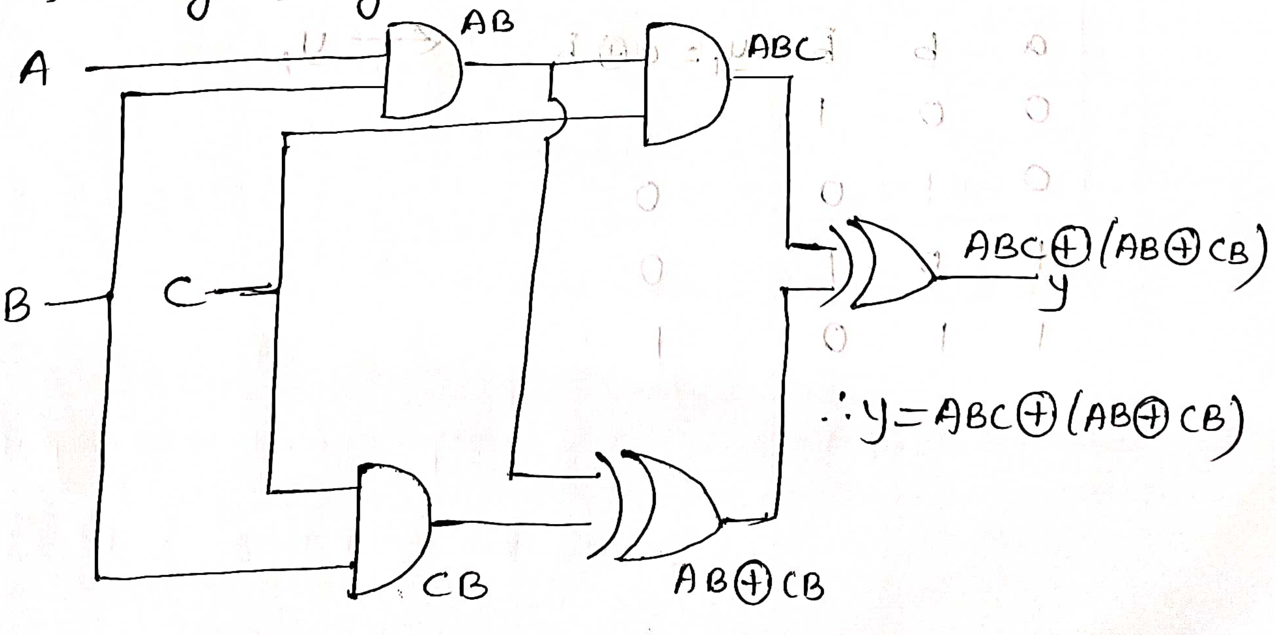
010	011	001	101
↓	↓	↓	↓
2	3	1	5

$F(x,y,z) = \Pi(1,2,3,5)$

$= \Pi(m_1, m_2, m_3, m_5)$

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

i)



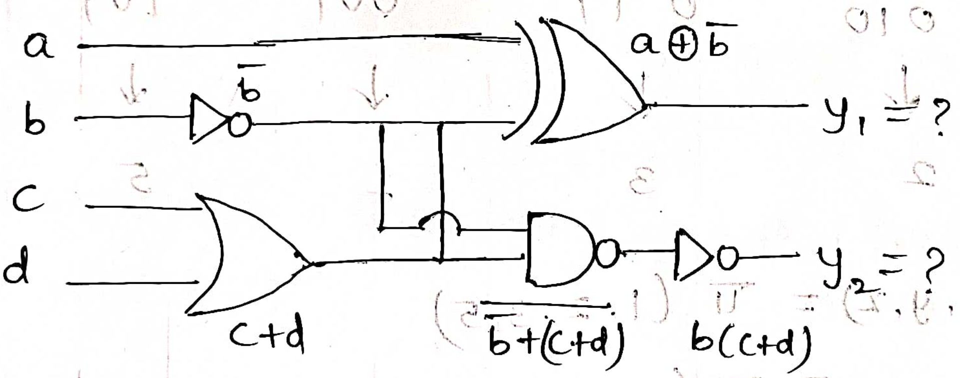
$\therefore y = ABC \oplus (AB \oplus CB)$

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

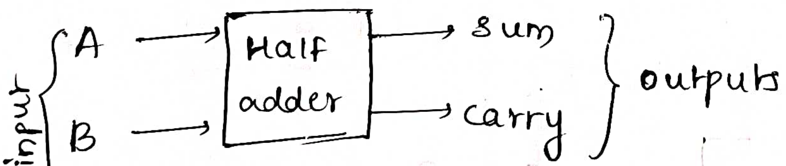
← y_2

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 :

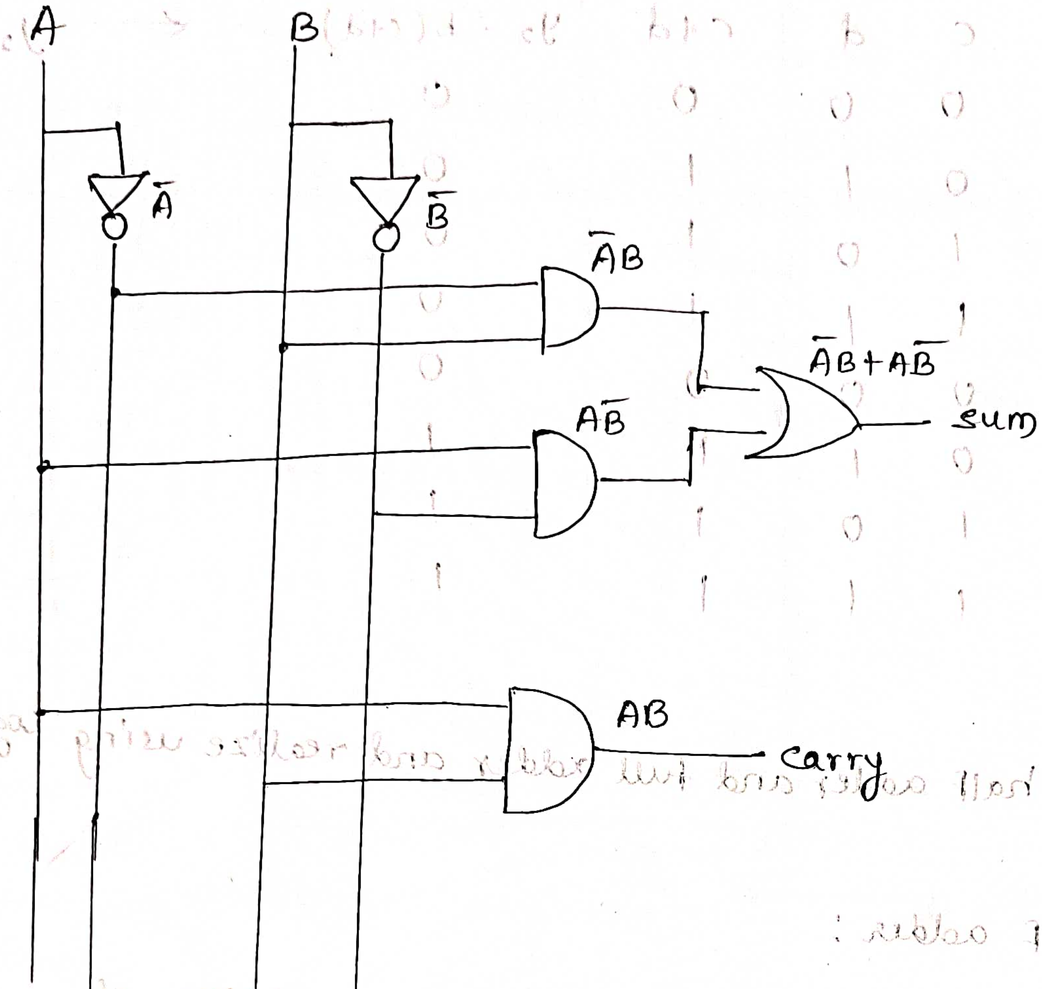
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Boolean expression :

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

$Carry = AB$

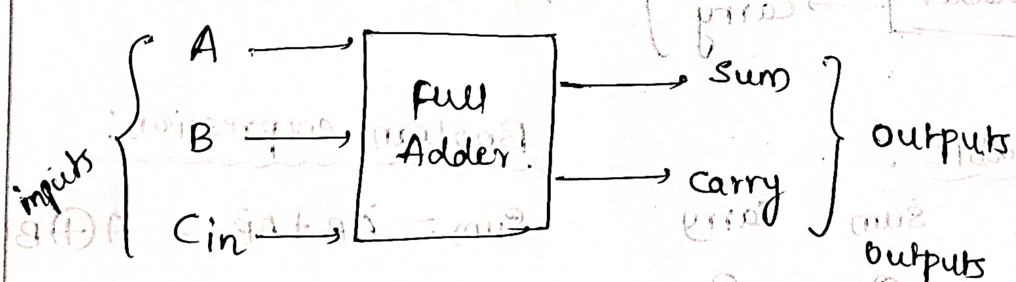
Logic diagram :



ii) Full Adder :

A full adder is a combinational circuit that performs the arithmatic 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:

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

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

After implementing basic gates,

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

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

Logic diagram :