$C_{in} \oplus (X \oplus Y)$

$C_{in}(X \oplus Y) + XY$

1. a. XOR gate

XOR gate has a symbol $\oplus$. When we have dissimilar number it gives logic 1 and for similar number gives logic 0.

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

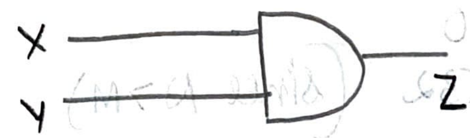
$Z = X \oplus Y$

b. AND gate

AND gate has a symbol $(\cdot)$ dot. When any one number is 0 answer is logic 0. If both are 1 it gives logic 1

X	Y	Z
0	0	0
0	1	0
1	0	0
1	1	1

$Z = X \cdot Y$



c. OR gate

OR gate has a symbol $(+)$. When any one is 1 it gives logic 1 or else logic 0.

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

$Z = X + Y$

d. NAND gate

It is complement of AND gate. Known as Not-And.

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

e. NOR gate

It is complement of OR gate. Known as Not-OR

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

10

2a) $M = 3250$

$N = 72532$ (since $N > M$)

1. Take 10's complement of N:
   For that 1st we take 9's complement then add 1

$$\begin{array}{r} 99999 \\ 72532 \\ \hline 27467 \\ +1 \\ \hline 27468 \end{array}$$

2. Now we add this with M

$$\begin{array}{r} 1\ \ 1\ \ \\ 27468 \\ 3250 \\ \hline 30718 \end{array}$$

3. Now we should take −(10's complement of 30718)

CMR

$$\begin{array}{r} 99999 \\ 30718 \\ \hline 69281 \\ +1 \\ \hline 69282 \end{array}$$

$\therefore -(69282)$ is the solution.

(b) M = 11101
N = 11000

~~Take 1's complement of N:~~
~~1) We take 2's complement then add 1:~~

$$\begin{array}{r} 11000 \\ 00111 \\ 1 \\ \hline 01000 \end{array}$$

~~2) we add this with M~~

$$\begin{array}{r} 01000 \\ 11101 \\ \hline 1\,|\,00101 \end{array}$$

~~we discard carry~~

~~$\therefore$ (01101) is the solution.~~

3. (i) $(1011011)_2 \rightarrow (\ )_{16}$

$(\underbrace{0101}\,\underbrace{1011})_2 \rightarrow \boxed{(5B)_{16}}$

we grp 4 Binary to get corresponding Hexadecimal

(ii) $(65.45)_{10} = (\ )_2$ \$ $(\ )_8$

$$\begin{array}{r|ll} 2 & 65 & \\ 2 & 32 & 1 \\ 2 & 16 & 0 \\ 2 & 8 & 0 \\ 2 & 4 & 0 \\ 2 & 2 & 0 \\ & 1 & 0 \end{array}$$

$(65)_{10} \rightarrow (1000001)_2$

$(.45)_{10} \rightarrow (0111001)_2$

	Fraction	Integer
0.45×2	0.9	0
0.9×2	1.8	1
0.8×2	1.6	1
0.6×2	1.2	1
0.2×2	0.4	0
0.4×2	0.8	0
0.8×2	1.6	1

$\therefore (65.45)_{10} \rightarrow \boxed{(1000001.0111001)_2}$

CMR

$(65.45)_{10} = (\quad)_8$

	Fraction	Integers
0.45 × 8	3.6	3
0.6 × 8	4.8	4
0.8 × 8	6.4	6
0.4 × 8	3.2	3
0.2 × 8	1.6	1
0.6 × 8	4.8	4
0.8 × 8	6.4	6

$8 \,|\, 65$
$8 \,|\, 8 \quad 1$
$\quad 1 \quad 0$

$(65)_{10} \to (101)_8$

$(0.45)_{10} \to (3463146)_8$

$(65.45)_{10} \to \boxed{(101.3463146)_8}$

(iii) $(4673)_8 \to (\quad)_2$

010 110 111 011

$(4673)_8 \to \boxed{(010110111011)_2}$

Find binary for each digit

(iv) $(ABC)_{16} \to (\quad)_8$

10 11 12

A 10 → 1010
B 11 → 1011
C 12 → 1100
D 13

101 010 111 100 → $\boxed{(5274)_8}$

(v) $(12988.86)_{16} \to$

16 | 12988
16 | 811   12
16 | 50   11
     3   2

(32BC)

	Fraction	Integers
0.86 × 16	13.76	13
0.76 × 16	12.16	12
0.16 × 16	2.56	2
0.56 × 16	8.96	8
0.96 × 16	15.36	15

$(12988.66)_{12} \to \boxed{(32BC.DC28F)_2}$

4. 2nd complement

a. 125 − 68
M = 125
N = 68
Taking 68's 2's complement

For that 1st we need to convert to binary

2 | 68
2 | 34 0
2 | 17 0
2 | 8 1
2 | 4 0
2 | 2 0
1 0

1000100 → 1st complement → 0111011

$$\begin{array}{r} 0111011 \\ +\ 1 \\ \hline 0111100 \end{array}$$

Now 125 is

2 | 125
2 | 62 1
2 | 31 0
2 | 15 1
2 | 7 1
2 | 3 1
1 1

1111101

Add:

$$\begin{array}{r} 0111100 \\ 1111101 \\ \hline [1]\ 0111001 \end{array}$$

We should discard carry

80 (0111001)

b) 16-83

2 | 16
2 | 8 0
2 | 4 0
2 | 2 0
1 0

M = 10000

2 | 83
2 | 41 1
2 | 20 1
2 | 10 0
2 | 5 0
2 | 2 1
1 0

N = 1010011

Take N's 2's complement ⇒

$$\begin{array}{r} 0101100 \\ 1 \\ \hline 0101101 \end{array}$$

Add

$$\begin{array}{r} 0010000 \\ 0101101 \\ \hline 0111101 \end{array}$$

-(2nd complement of 0111101)

$$\Rightarrow \begin{array}{r} 1000010 \\ 1 \\ \hline 1000011 \end{array}$$

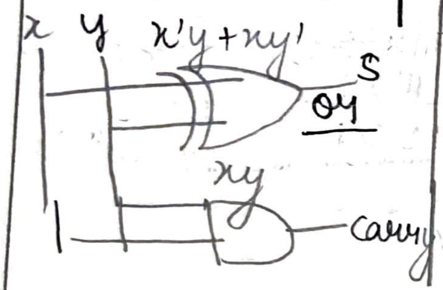
∴ $\boxed{-(1000011)}$

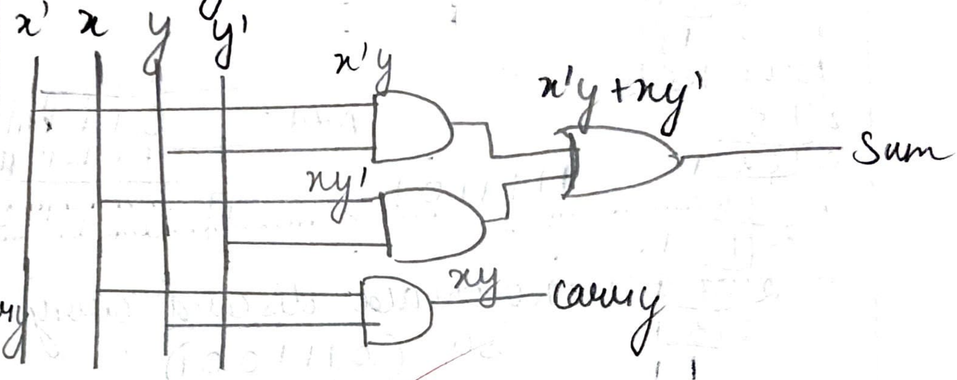
5. i) Half Adder: Half adder do not carry. They take two input and give 2 output

X	Y	C	S
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

$S = x'y + xy' = X \oplus Y$

$C = xy$





2) Full adder: It takes carry. There are 3 input and 2 output

X	Y	Z	Cout	S
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

$S = x'y'z + x'yz' + xy'z' + xyz$

$S = x'y'(z+z') + x(y'z' + yz)$

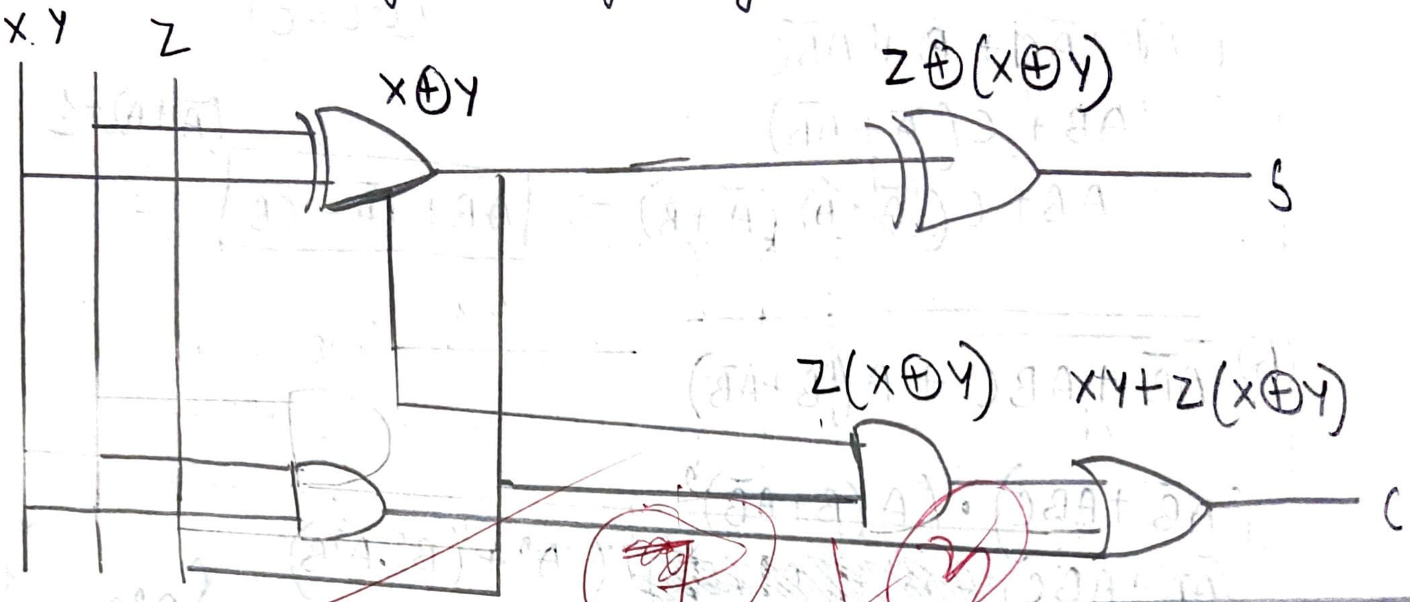
$S = x'y' + x(y'+y)(z'+z)(y+z)(y'+z)$
$(z+y')$

$\boxed{S = Z \oplus (X \oplus Y)}$

$Cout = x'yz + xy'z + xyz' + xyz$

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

$\boxed{Z(X \oplus Y) + XY}$



2(b) $(11101)_2 - (11000)_2 = (\ \ )_2$

M − N

First take 1^s complement of N = 00111

Add with N →

$$
\begin{array}{r}
00111 \\
+\ 1 \\
\hline
01000
\end{array}
\quad 2nd
$$

$$
\begin{array}{r}
01000 \\
11101 \\
\hline
1\,]\,00101
\end{array}
$$

→ 00101

∴ 101 is the solution

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

(a) $AB + \bar{A}C + A\bar{B}C \cdot AB + C \cdot A\bar{B}C$ $\quad \left\{ \begin{array}{l} A \cdot A = A \\ C \cdot C = C \end{array} \right\}$ $\quad \bar{B} \cdot B = 0$

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

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

$AB + C(\cancel{(\bar{A} + A)}(\bar{A} + \bar{B}) \Rightarrow \boxed{AB + C\bar{A} + C\bar{B}}$

2

(b) $\overline{\overline{A\bar{B}} + ABC + A(B + A\bar{B})}$

$(A\bar{B} + ABC) \cdot (A(B + A\bar{B}))'$

$(A\bar{B} + ABC) \cdot$ $(A' + (B' \cdot A'B)$ $\quad \{B'B = 0\}$

$(A\bar{B} + ABC) \cdot (A' + \underbrace{B'A'B}_{0})$

$(A\bar{B} + ABC) \cdot (A')$

$A'A\bar{B} + AA'BC \Rightarrow \boxed{0}$ $\quad \{AA' = 0\}$

5

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

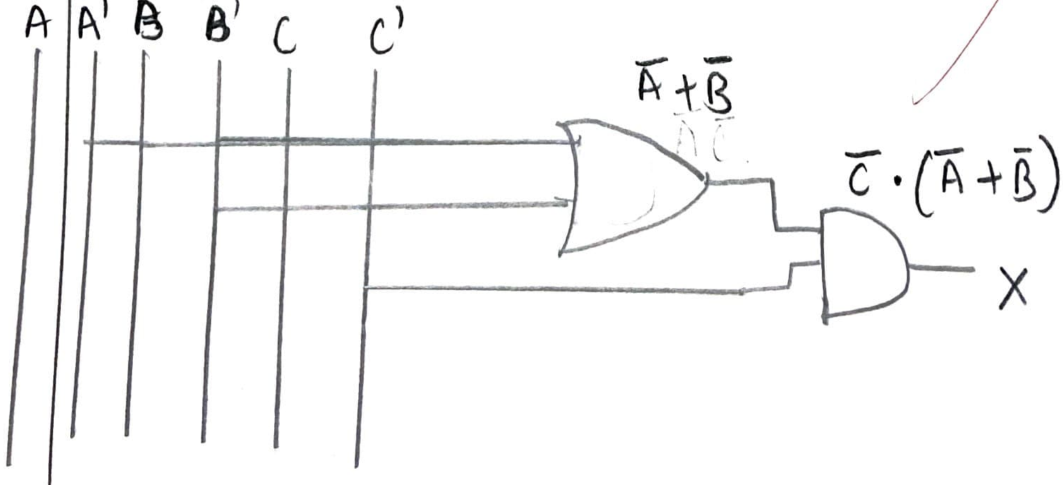
$\bar{A}\bar{C}(\bar{B} + B) + A\bar{B}\bar{C}$ $\quad \{(\bar{B} + B) = 1\}$

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

$\bar{C}(\bar{A} + A\bar{B})$ $\quad$ {distributive law}

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

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



	A	B	C	$\overline{A}$	$\overline{B}$	$\overline{A}+\overline{B}$	$\overline{C}$	$\overline{C}\cdot(\overline{A}+\overline{B})$
0	0	0	0	1	1	1	1	1
1	0	0	1	1	1	1	0	0
2	0	1	0	1	0	1	1	1
3	0	1	1	1	0	1	0 1	0
4	1	0	0	0	1	1	0	1
5	1	0	1	0	1	1	1	0
6	1	1	0	0	0	0	1	0
7	1	1	1	0	0	0	0	1

$\Rightarrow \Sigma M_0 + M_2 + M_4 + M_7$

$x'y'z' + x'yz' + xy'z' + xyz$

$= a'b'c' + a'bc' + ab'c' + abc$

equal to $\Rightarrow$ $\boxed{\text{to the given equation}}$