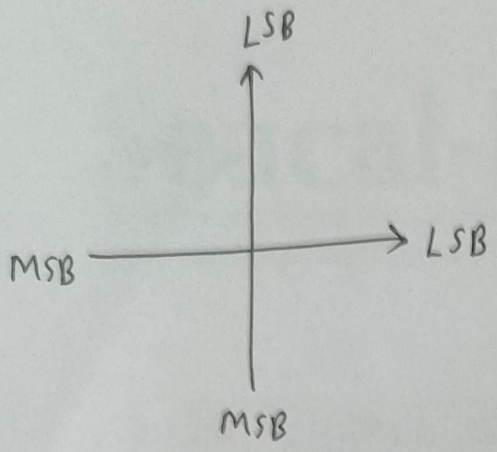
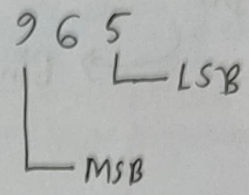
L-1 / 25.01.2023 /

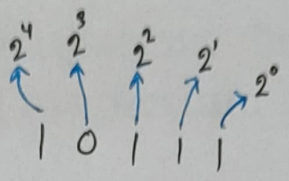
bit → digit

bit → Binary

L-2 / 30.01.2023







2^{n-1} ; n = no of bit

* $41_{10} \longrightarrow ?_2$

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

$= 101001$

$101001_2 = ?_{10}$

$1\times2^5 + 0\times2^4 + 2^3\times1 + 2^2\times0 + 0\times2^1 + 1\times2^0$

$= 32 + 8 + 1$

$= 41_{10}$

$$
\begin{array}{r}
1011 \longrightarrow 11 \\
+\ 1101 \longrightarrow +\ 13 \\
\hline
11000 \longrightarrow 24
\end{array}
$$

$$
\begin{array}{r}
1101 \longrightarrow 13 \\
-\ 1001 \longrightarrow 9 \\
\hline
0100 \longrightarrow 4
\end{array}
$$

$$
\begin{array}{r}
1101 \longrightarrow 13 \\
-\ 1010 \longrightarrow 10 \\
\hline
0011 \longrightarrow 3
\end{array}
$$

$$
\begin{array}{r}
110 \longrightarrow 6 \\
\times\ 111 \longrightarrow 7 \\
\hline
110 \\
1100 \\
11000 \\
\hline
1010110 \longrightarrow 42
\end{array}
$$

$$
\begin{array}{r|l}
 & 100 \longrightarrow 4 \\
\hline
11 & 1100 \longrightarrow 12 \\
 & 11 \\
\hline
 & 00
\end{array}
$$

3

$$
\begin{array}{r|l}
 & 111 \longrightarrow 7 \\
\hline
110 & 101010 \longrightarrow 42 \\
 & 110 \\
\hline
 & 01001 \\
 & 110 \\
\hline
 & 110 \\
 & 110 \\
\hline
 & 0
\end{array}
$$

6

$$
\begin{array}{r}
10110010 \\
01001101 \longrightarrow 1^{s} \text{ Complement} \\
+\ 1 \\
\hline
01001110 \longrightarrow 2^{s} \text{ Complement}
\end{array}
$$

L-3 / 01.02.2023

+39 = 00100111

-39 = 10100111

1's complement of -39 = 11011000

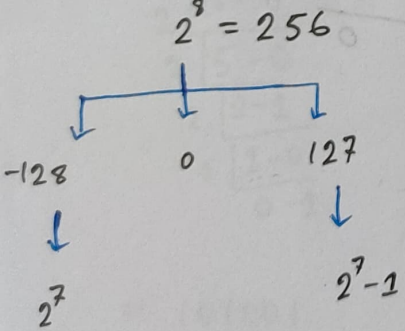
2's complement of -39 = 11011001

a)

```
  00001000  ------> 8
(+) 11111101  ------> -3
-------------------------
 1|00000101  ------> 5
```

Discard Carry Bit

```
  0000 1000  ------> 8
(-) 0000 0011  ------> 3
-------------------------
    0000 0101  ------> 5
```



∴ Range : $-(2^{n-1})$ to $(2^{n-1} - 1)$

✳ 32768×32768

$= 1.07 \times 10^{9}$ → Exponent

→ Fraction/Mantissa

S	Exponent (E)	Fraction (F)
1 bit	8 bit	23 bit

$$\text{Number} = (-1)^{S}(1+F)(2^{E-127})$$ → Biased exponent

✳ Mid Question Must ✳✳✳

$$32480 = 1.1111110\ 111\ 00000 \times 2^{14}$$ → E

$$E = 14 + 127 = 141_{10} = 10001101_{2}$$

0	10001101	11111011100000000000000
1 bit	8 bit	23 bit

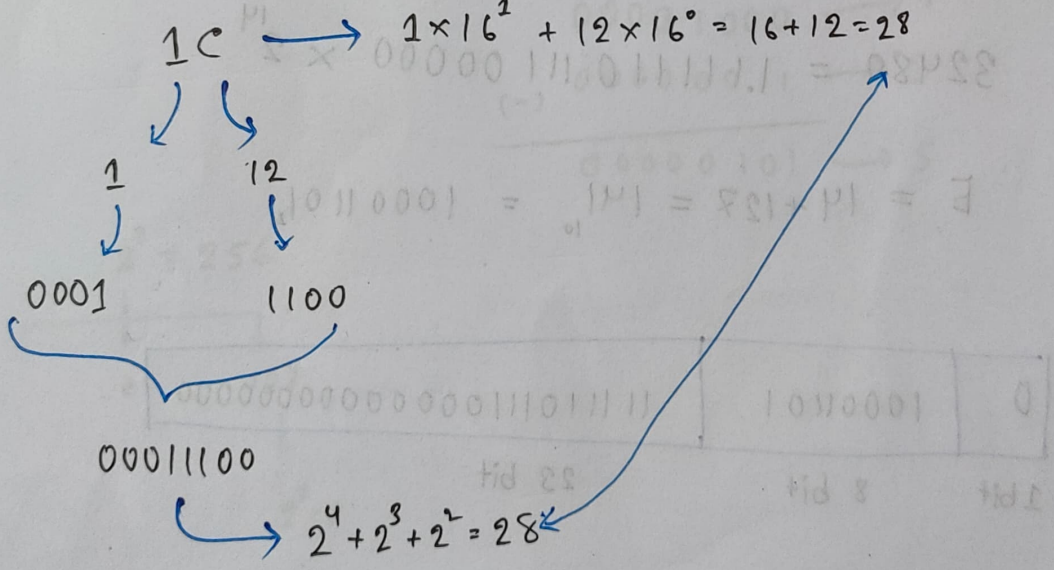
1	10010001	10001110000000000000

$10010001 = 1+16+128 = 145$

$\therefore E = 145$

$\therefore \text{Number} = (-1)^1 (1.10001110001)(2^{145-127})$

$= -11000111000100000000$



L-4 / 06.02.2023 /

⊛ $EF9A = x_{16}$

$x_2 = 1110\ 1111\ 1001\ 1010$

$x_8 = 167632$

$x_{10} = (14\times16^3) + (15\times16^2) + (9\times16^1) + (10\times16^0)$

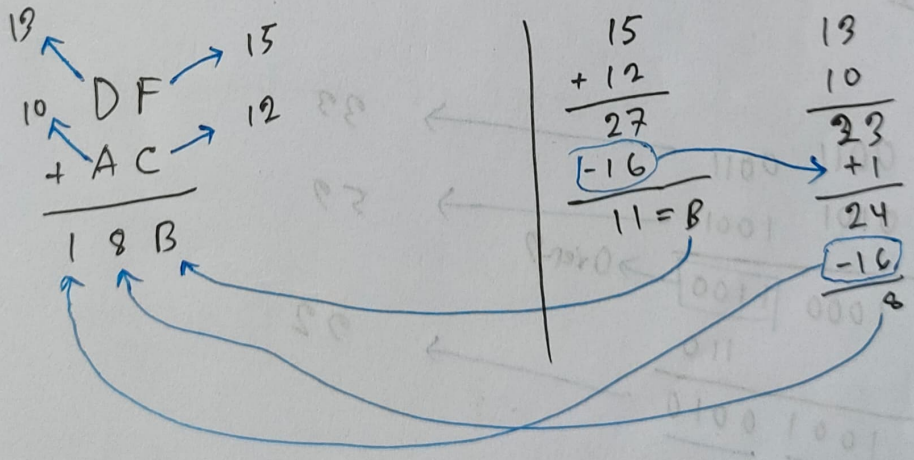
$= 61338$

⇒

16 | 61338
16 | 3833 - 10 → A
16 | 239 - 9 → 9
16 | 14 - 15 → F
0 - 14 → E

$\therefore x_{16} = EF9A$

⊛



⊛ BCD → Most Important for mid & Quiz

⊛

a) $2BD9_{16} = 2\times16^3 + 11\times16^2 + 13\times16 + 9\times1$

$= 8192 + 2816 + 208 + 9$

$= 11225_{10}$

0001 0001 0010 0010 0101 ⇒ BCD

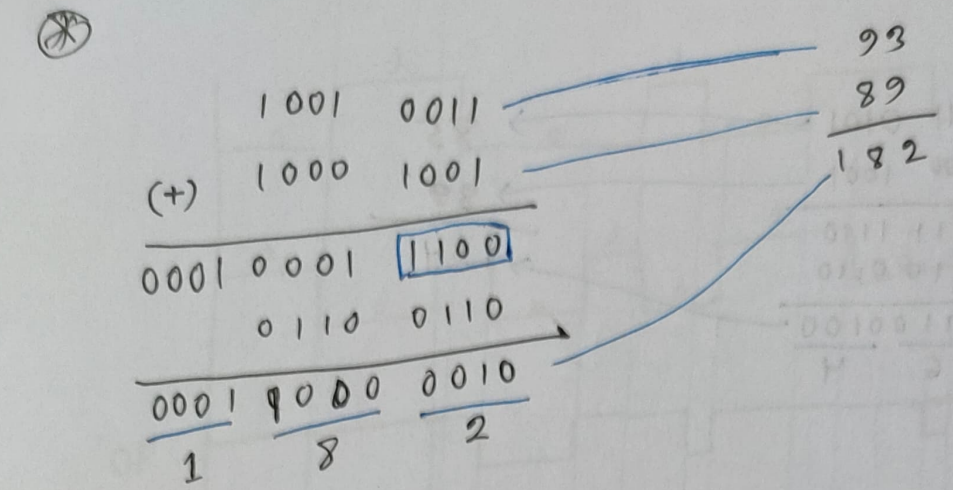
b)

```
  0011 0011  ──→  33
(+) 1001 0101  ──→  95
  ──────────
  1100 1000
   110
  ──────────
  0001 0010 1000  ──→  128
  1    2    8
```

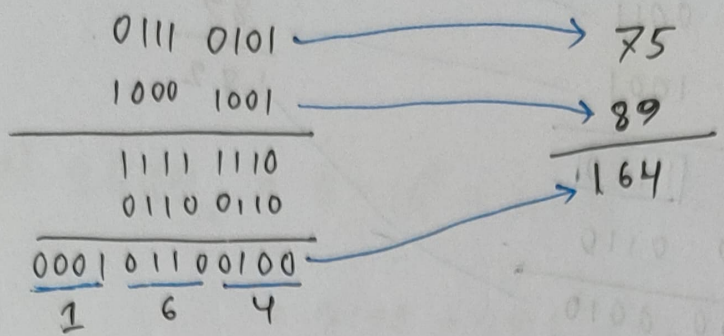
Over 9

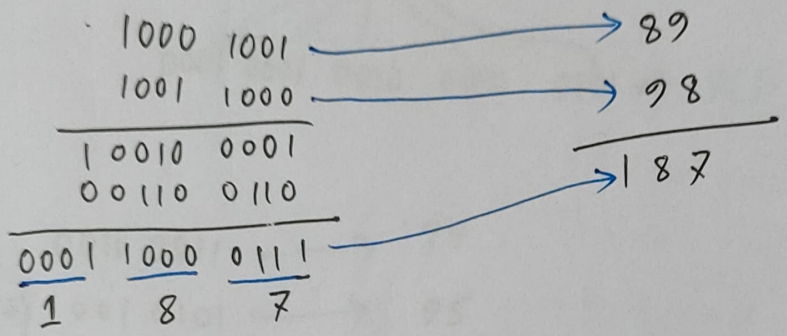
⊛

```
  0011 0011  ──→  33
+ 0101 1001  ──→  59
  ──────────
  1000 1100  → Over 9
   110
  ──────────  ──→  92
  1001 0010
  9    2
```



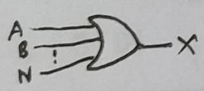
L-5 / 08.02.2023 /





✳ Semi-conductor → diode → Logic Grate

✳ In Truth Table, number of combination = 2^n (n → no. of input)

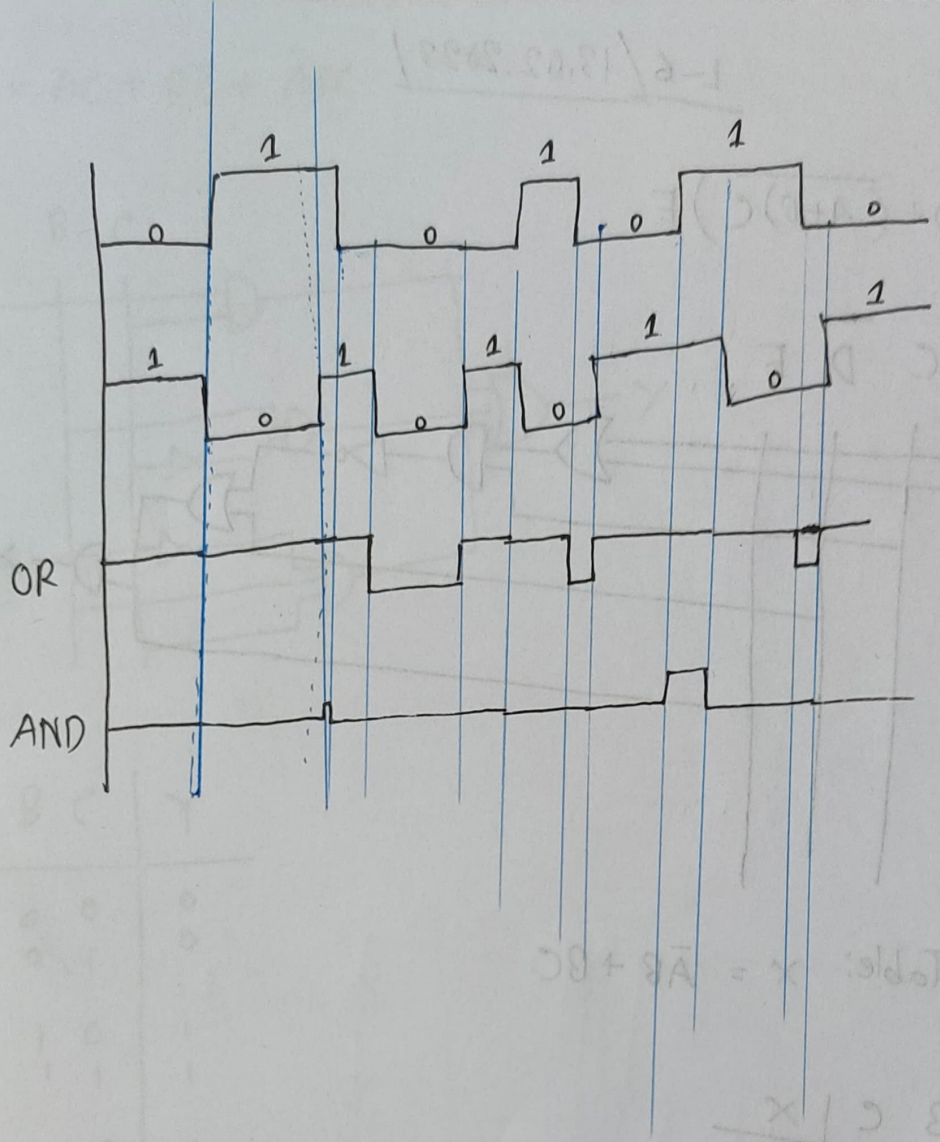


✳ Boolean Expression:

$X = A + B$ (+ → OR)

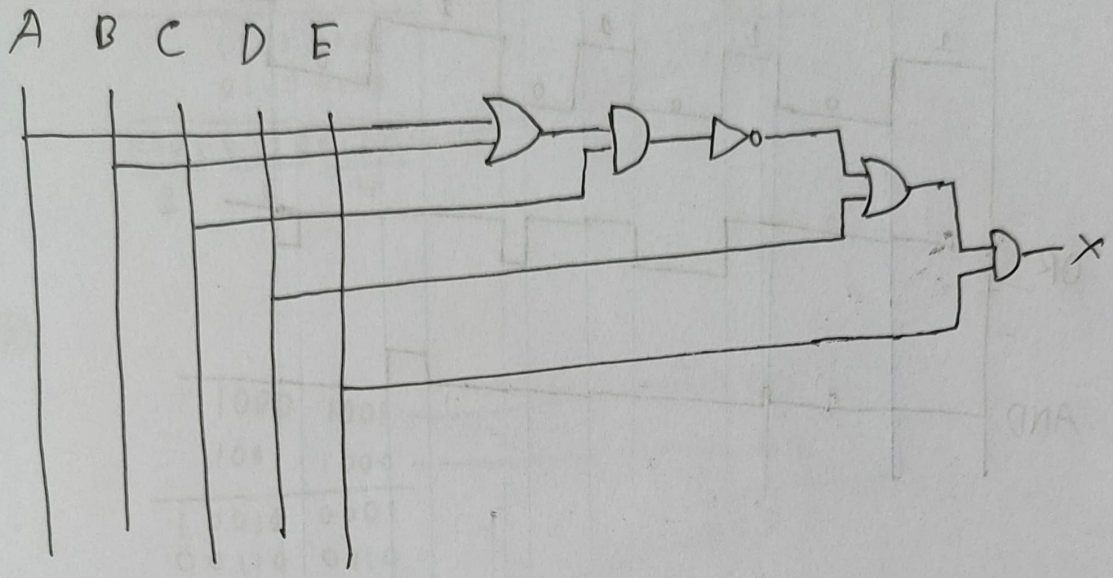
✳ Truth Table

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1



L-6 / 13.02.2023 /

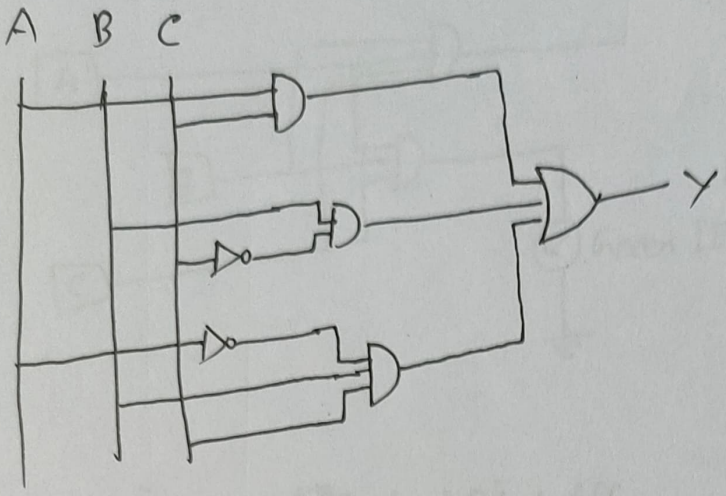
$X = (D + \overline{(A+B)C})E$



Truth Table: $X = \bar{A}B + BC$

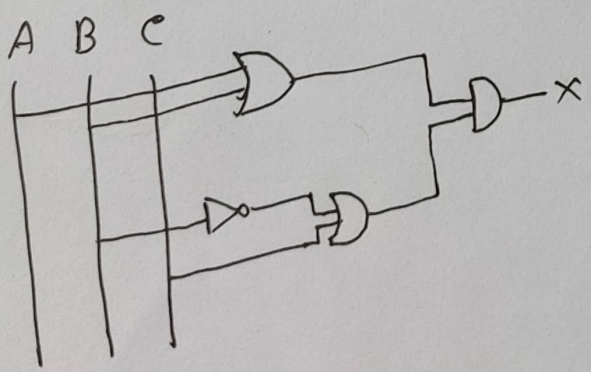
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

✱ $Y = AC + B\bar{C} + \bar{A}BC$



A	B	C	Y
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

✱ $X = (A+B)(\bar{B}+C)$



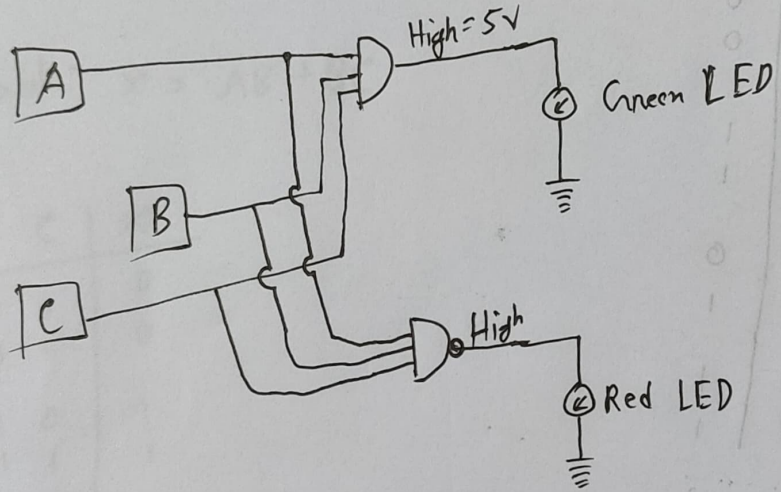
T.T.

A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

(*) Extended = High

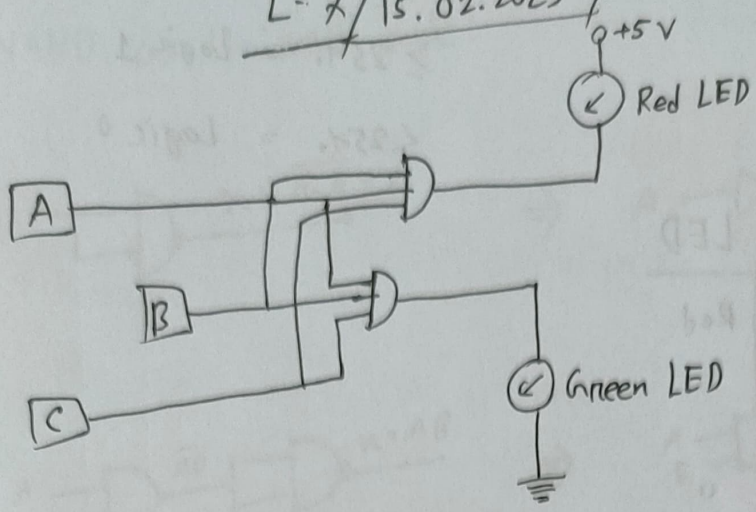
Retracted = Low

A	B	C	X	
0	0	0	0	Red
0	0	1	0	
0	1	0	0	
0	1	1	0	
1	0	0	0	
1	0	1	0	
1	1	0	0	Red
1	1	1	1	Green

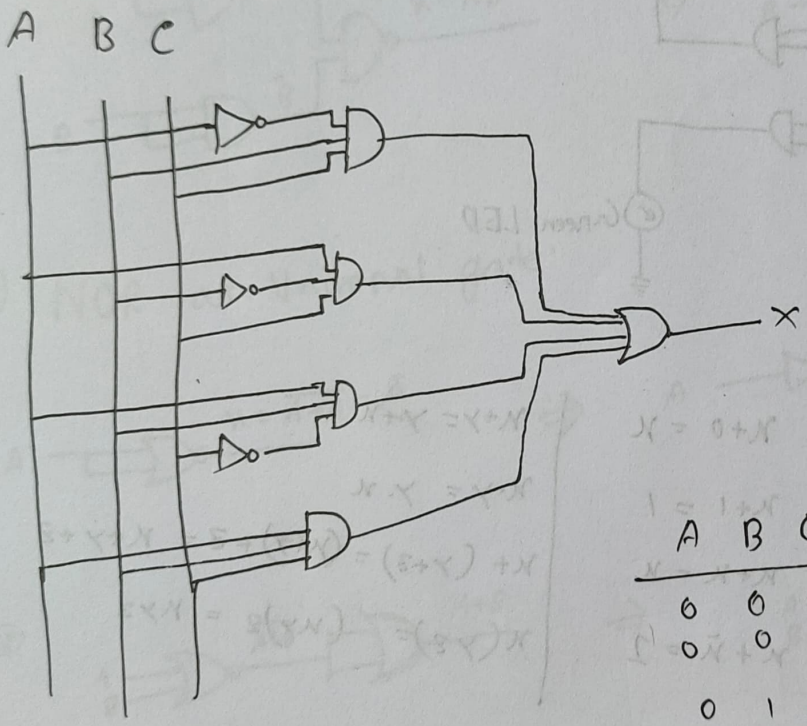


(*) Page - 20 : Using One Gate :

L-7/15.02.2023



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



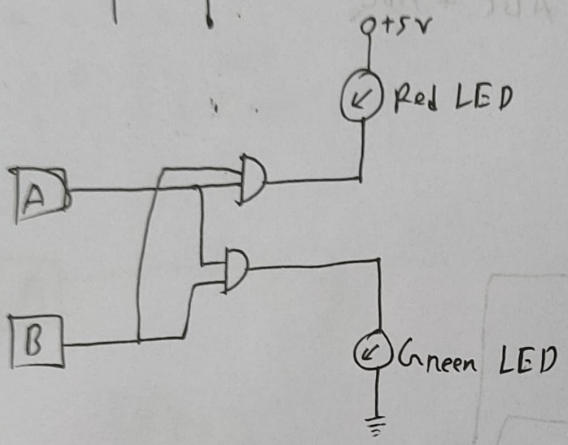
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Tank Question:

$\geq 25\%$ = Logic 1

$< 25\%$ = Logic 0

A	B	Y	LED
0	0	0	Red
0	1	0	"
1	0	0	"
1	1	1	Green



$A \cdot 0 = 0$	$x + 0 = x$	$x + y = y + x$
$x \cdot 1 = x$	$x + 1 = 1$	$x \cdot y = y \cdot x$
$x \cdot x = x$	$x + x = x$	$x + (y + z) = (x + y) + z = x + y + z$
$x \cdot \bar{x} = 0$	$x + \bar{x} = 1$	$x(yz) = (xy)z = xyz$

$x(y+z) = xy + xz$

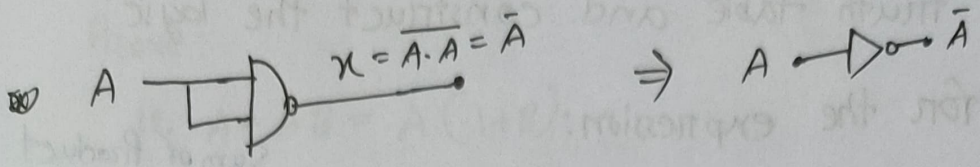
$(w+x)(y+z) = wy + xy + wz + xz$

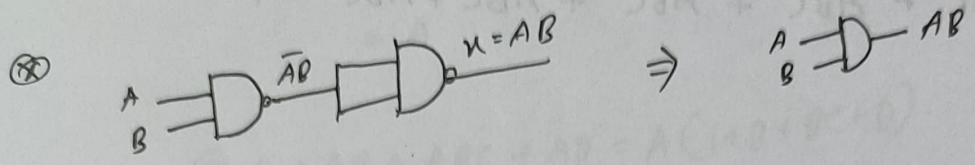
$x + xy = x$

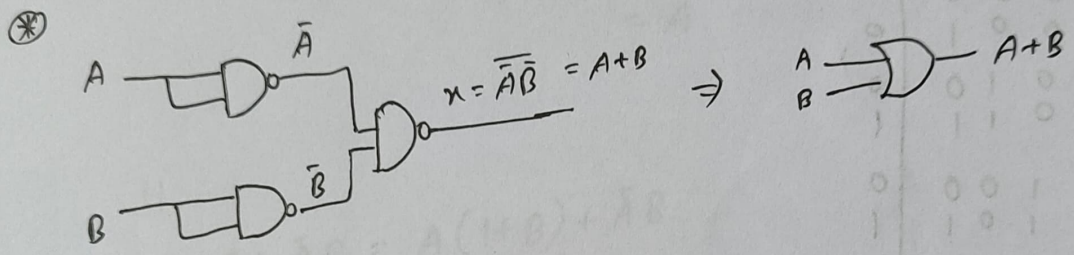
$x + \bar{x}y = x + y$

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

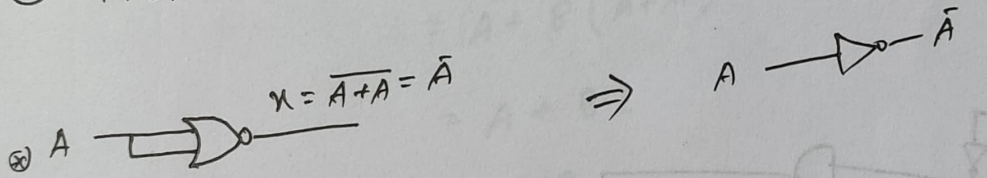
NAND as Universal gate:

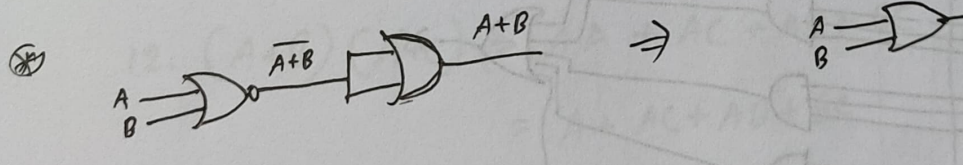


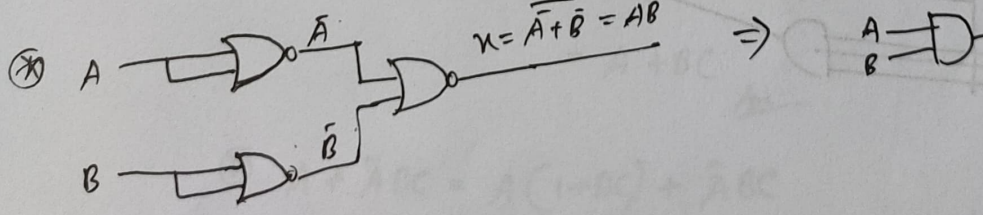




NOR as Universal gate:







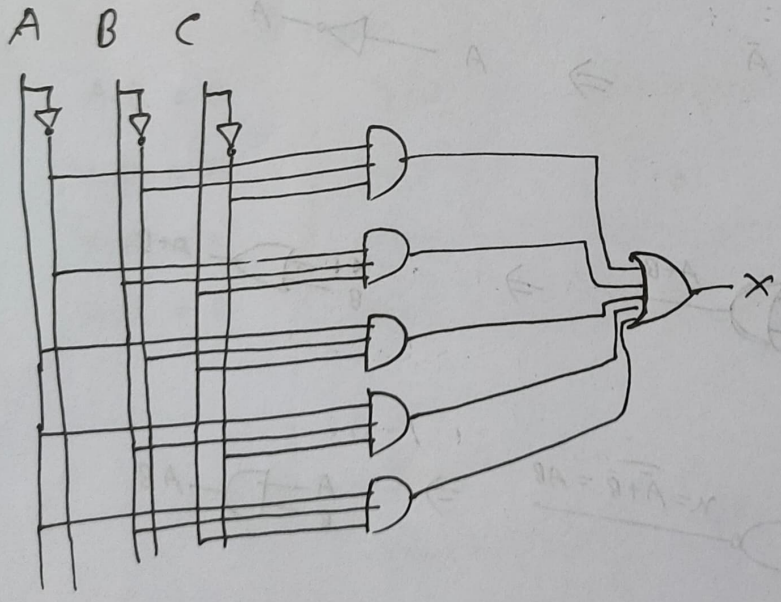
L-8/20.02.2023/

⊛ Draw the truth table and construct the logic circuit for the expression:

Sum of Product

$$X = \bar{A}\bar{B}\bar{C} + \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC \rightarrow SOP$$

A	B	C	X
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



⊛ Basic Rule of Boolean Algebra from Slide.

Prove:

10. $A + AB = A(1+B)$

$= A \cdot 1$

$= A$

⊛ $A + AB + ABC + AD = A(1 + B + BC + D)$

$= A \cdot 1$

$= A$

11. $A + \bar{A}B = A(1+B) + \bar{A}B$

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

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

$= A + B \cdot 1$

$= A + B$

12. $(A+B)(A+C) = A \cdot A + AC + AB + BC$

$= A + AC + AB + BC$

$= A(1 + C + B) + BC$

$= A + BC$

⊛ $A + \bar{A}BC = A(1+BC) + \bar{A}BC$

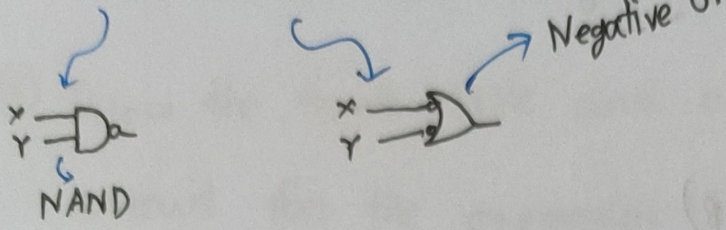
$= A + ABC + \bar{A}BC$

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

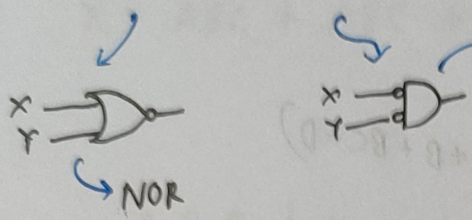
$= A + BC \cdot 1$

$= A + BC$

(*) $\overline{XY} = \bar{X} + \bar{Y}$



(2) $\overline{X+Y} = \bar{X}\bar{Y}$



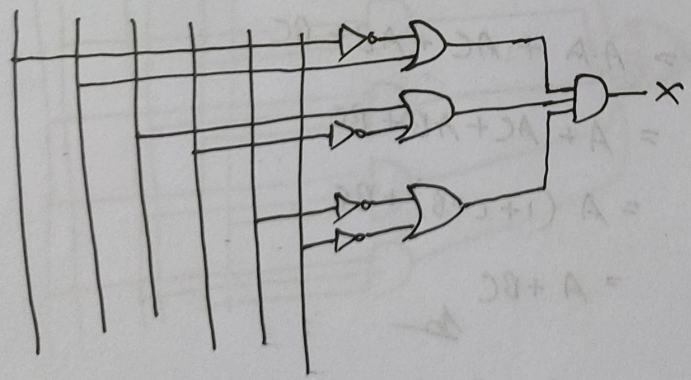
(*) D'Morgans Law Prove from Slide 4, Page-11 (Quiz-2 Must)

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

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

$= (\bar{A} + B)(C + \bar{D})(\bar{E} + \bar{F}) \rightarrow$ POS

A B C D E F



A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

$\Rightarrow$ XOR $\Rightarrow \bar{A}B + A\bar{B}$

XNOR $\Rightarrow \overline{\bar{A}B + A\bar{B}}$

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

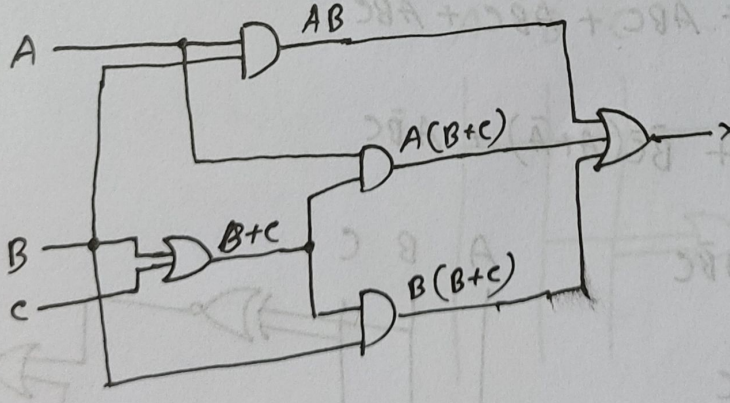
$= (A + \bar{B})(\bar{A} + B)$

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

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

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

A	B	X	
0	0	1	$\rightarrow \bar{A}\bar{B}$
0	1	0	
1	0	0	
1	1	1	$\rightarrow AB$



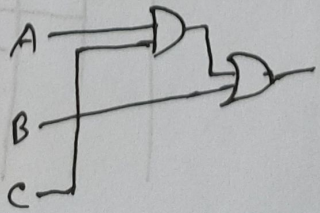
$x = AB + A(B+C) + B(B+C)$

$= AB + AB + AC + BB + BC$

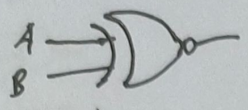
$= AB + AC + B + BC$

$= AC + B(A + 1 + C)$

$= B + AC$



L-10/27.02.2023



XNOR

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

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

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

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

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

$= XNOR$

A	B	x
0	0	1
0	1	0
1	0	0
1	1	1

$x = \overline{\bar{A}\bar{B} + AB} = A\bar{B} + \bar{A}B$

(XOR)

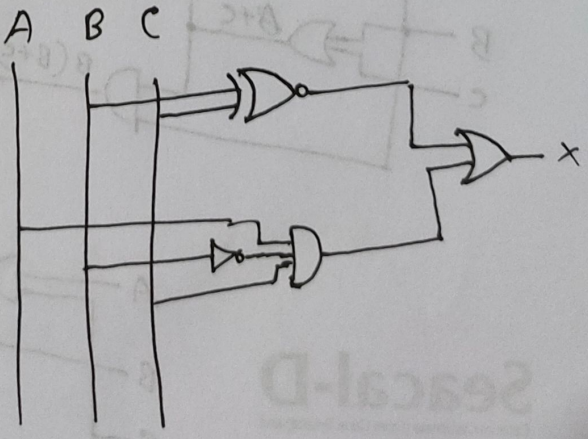
(*)

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

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

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

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



$$x = \overline{AB+AC} + \bar{A}\bar{B}C \longrightarrow 7 \text{ Gates}$$

$$= \overline{AB} \cdot \overline{AC} + \bar{A}\bar{B}C$$

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

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

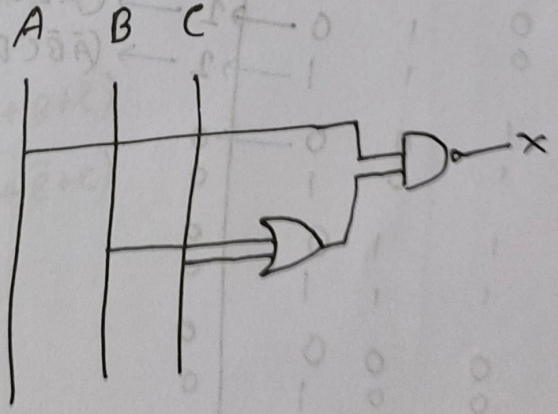
$$= \bar{A} + \bar{A}C + \bar{A}\bar{B} + \bar{B}\bar{C} + \bar{A}\bar{B}C$$

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

$$= \bar{A} + \bar{B}\bar{C} \longrightarrow 5 \text{ Gates}$$

$$= \bar{A} + \overline{B+C} \longrightarrow 3 \text{ Gates}$$

$$= \overline{A(B+C)} \longrightarrow 2 \text{ Gates}$$



⊛ $A\bar{B}C + \bar{A}\bar{B} + AB\bar{C}D \longrightarrow$ make it Std SOP

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

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

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

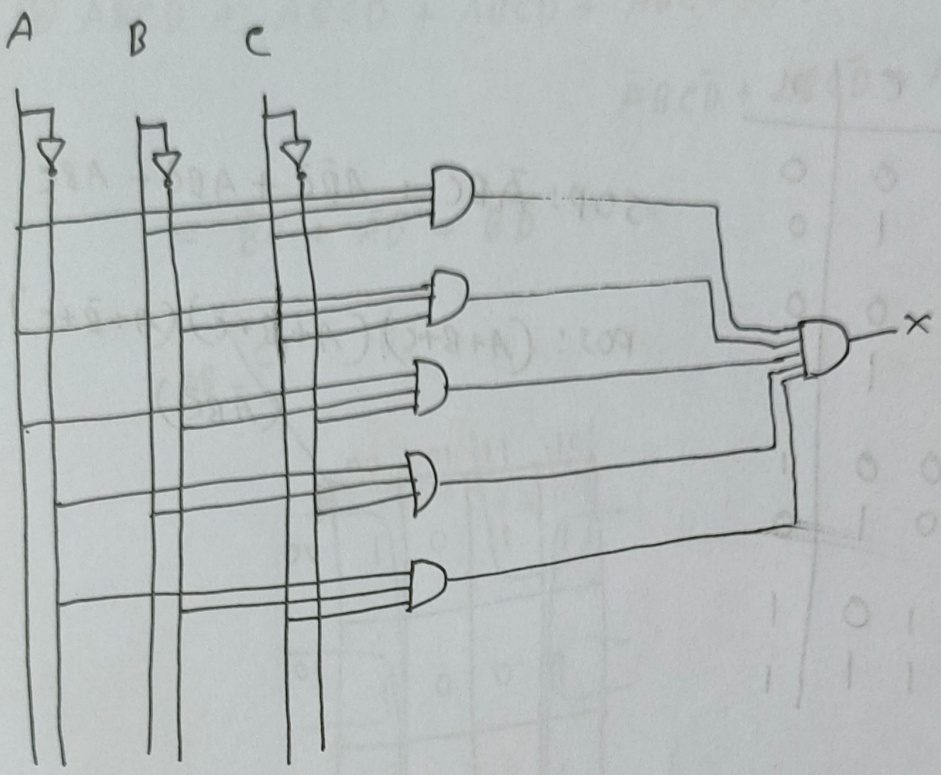
$= A\bar{B}CD + A\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D} + AB\bar{C}D$

= Std SOP.

T.T

A	B	C	D	x	
0	0	0	0	1	$(\bar{A}\bar{B}\bar{C}\bar{D})$
0	0	0	1	1	$(\bar{A}\bar{B}\bar{C}D)$
0	0	1	0	1	$(\bar{A}\bar{B}C\bar{D})$
0	0	1	1	1	$(\bar{A}\bar{B}CD)$
0	1	0	0	0	
0	1	0	1	0	
0	1	1	0	0	
0	1	1	1	0	
1	0	0	0	0	
1	0	0	1	0	
1	0	1	0	1	$(A\bar{B}C\bar{D})$
1	0	1	1	1	$(A\bar{B}CD)$
1	1	0	0	0	
1	1	0	1	1	$(AB\bar{C}D)$
1	1	1	0	0	
1	1	1	1	0	

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



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

L-10 / 01.03.2023

A	B	C	x
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

SOP: $\bar{A}BC + A\bar{B}\bar{C} + AB\bar{C} + ABC$

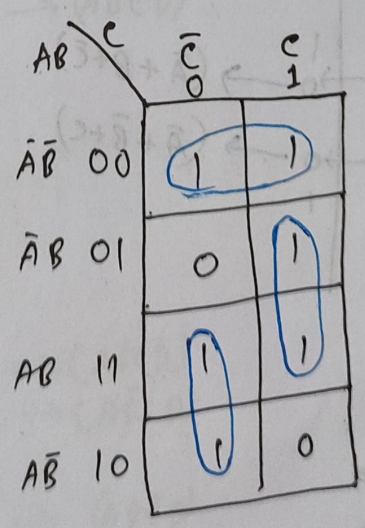
POS: $(A+B+C)(A+B+\bar{C})(A+\bar{B}+C)$ $(\bar{A}B\bar{C})$

Karnaugh Map:

A	B	C	x
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

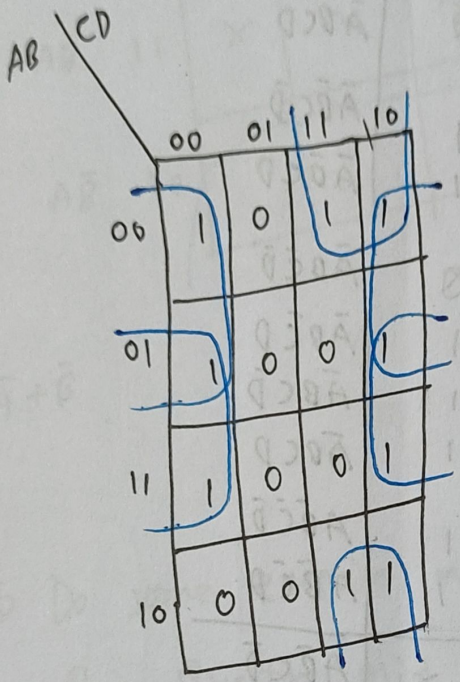
SOP: $\bar{A}BC + A\bar{B}\bar{C} + AB\bar{C} + ABC + \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}C$

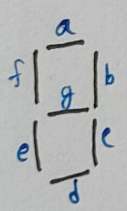
$= \bar{A}\bar{B} + BC + A\bar{C}$



(b) $\bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} + AB\bar{C}\bar{D} + \bar{A}\bar{B}CD + A\bar{B}CD + A\bar{B}\bar{C}\bar{D} + \bar{A}BC\bar{D} + ABC\bar{D} + A\bar{B}C\bar{D}$

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





a = 0 2 3 5 6 7 8 9

b = 0 1 2 3 4 7 8 9

c = 0 1 3 4 5 6 7 8 9

d = 0 2 3 5 6 8 9

e = 0 2 6 8

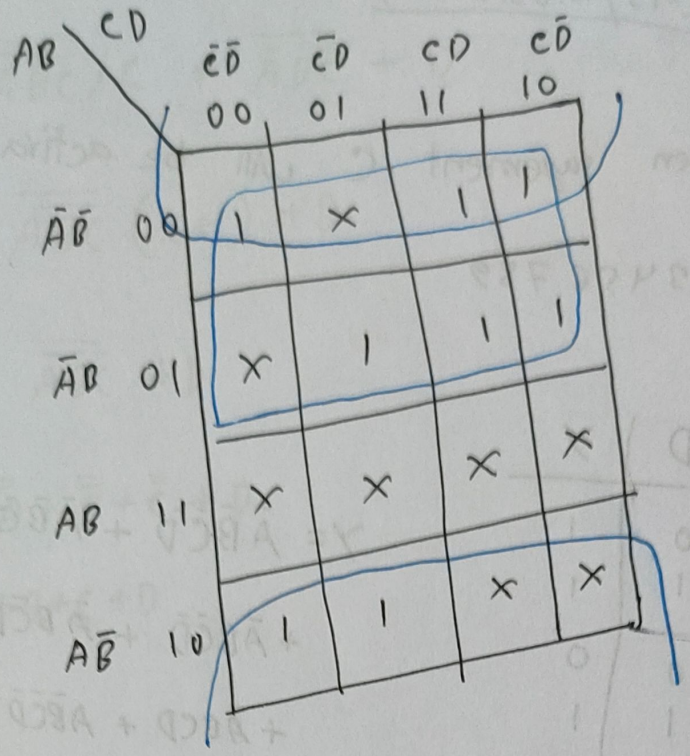
f = 0 4 5 6 8 9

g = 2 3 4 5 6 8 9

L-12 / 06.03.2023 /

For Sagment a:

	A	B	C	D	x	
0	0	0	0	0	1	$\bar{A}\bar{B}\bar{C}\bar{D}$
1	0	0	0	1	⊗	$\bar{A}\bar{B}\bar{C}D$
2	0	0	1	0	1	$\bar{A}\bar{B}C\bar{D}$
3	0	0	1	1	1	$\bar{A}\bar{B}CD$
4	0	1	0	0	⊗	$\bar{A}B\bar{C}\bar{D}$
5	0	1	0	1	1	$\bar{A}B\bar{C}D$
6	0	1	1	0	1	$\bar{A}BC\bar{D}$
7	0	1	1	1	1	$\bar{A}BCD$
8	1	0	0	0	1	$A\bar{B}\bar{C}\bar{D}$
9	1	0	0	1	1	$A\bar{B}\bar{C}D$
10	1	0	1	0	x	$A\bar{B}C\bar{D}$
11	1	0	1	1	x	$A\bar{B}CD$
12	1	1	0	0	x	$AB\bar{C}\bar{D}$
13	1	1	0	1	x	$AB\bar{C}D$
14	1	1	1	0	x	$ABC\bar{D}$
15	1	1	1	1	x	$ABCD$



$\therefore X = \bar{A} + \bar{B}$

⊛ Do some exercise for other segment Quiz Question, Mid Question Must.

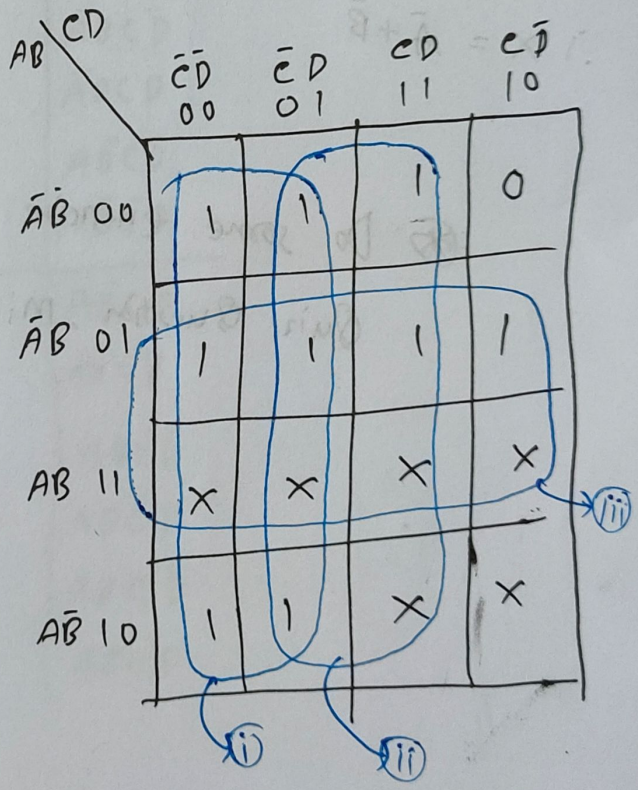
L-13 / 15.03.2023

✱ Numbers when sagement C will be activated:

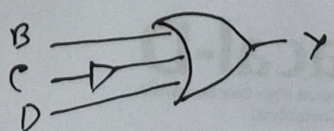
⇒ 0 1 3 4 5 6 7 8 9

A	B	C	D	Y
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	X
1	0	1	1	X
1	1	0	0	X
1	1	0	1	X
1	1	1	0	X
1	1	1	1	X

$$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}C\bar{D} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}D + \bar{A}BC\bar{D} + \bar{A}BCD + A\bar{B}\bar{C}\bar{D} + A\bar{B}\bar{C}D$$



$$\therefore Y = \bar{C} + D + B$$



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

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

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

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

$$= A + B + C + D$$

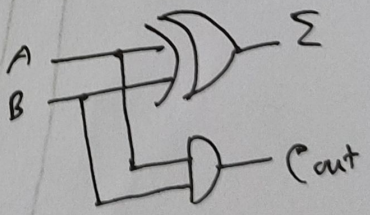
Half Adder

T.T.

A	B	Cout	Σ
0	0	0	0
0	1	0	$1 \rightarrow \bar{A}B$
1	0	0	$1 \rightarrow A\bar{B}$
1	1	1	0

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

∴

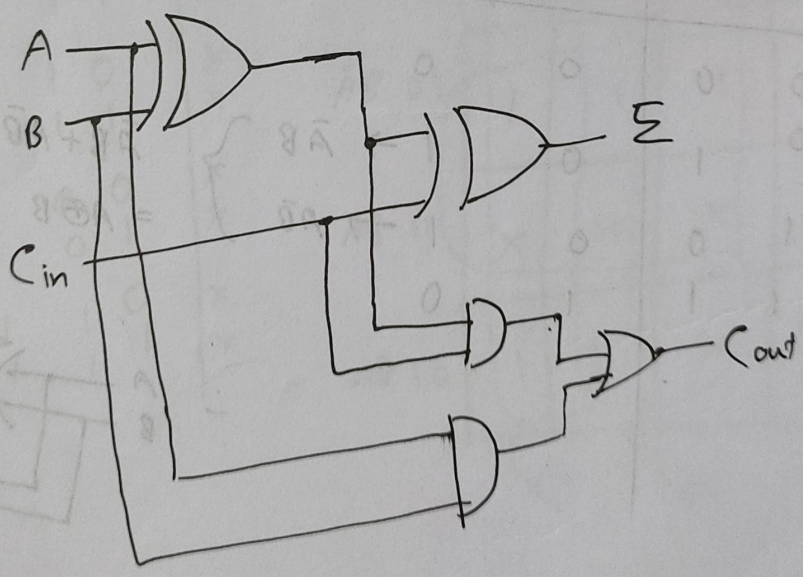


Full Adder

T.T.

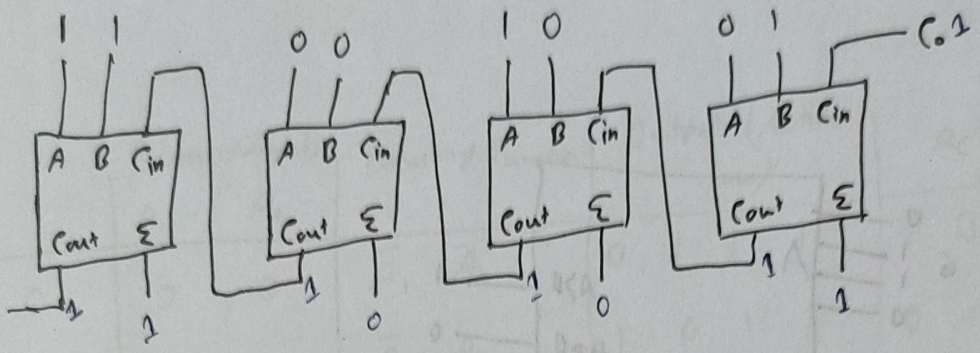
A	B	C_{in}	C_{out}	Σ
0	0	0	0	0
0	0	1	0	1
0	1	0	0	1
0	1	1	1	0
1	0	0	0	1
1	0	1	1	0
1	1	0	1	0
1	1	1	1	1

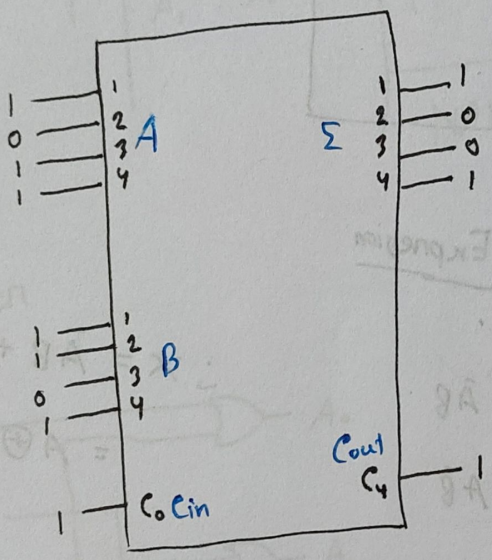
$\Rightarrow (A \oplus B) \oplus C_{in}$



(*) A = 1010

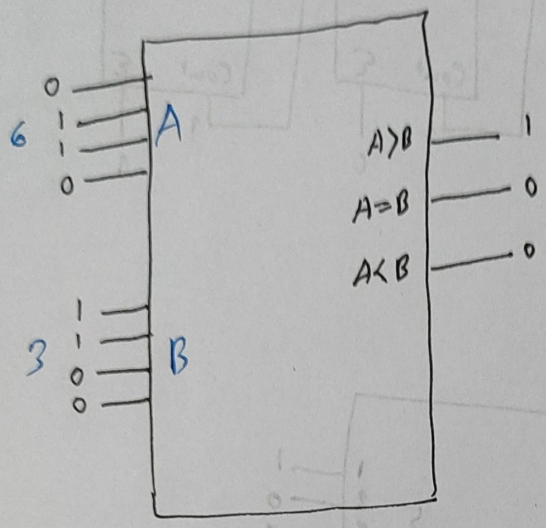
B = 1001





L-14 / 20.03.2023 /

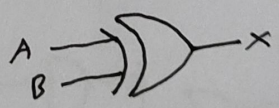
Comparator



A	B	X	Expression
0	0	0	
0	1	1	$\bar{A}B$
1	0	1	$A\bar{B}$
1	1	0	

$\therefore X = \bar{A}B + A\bar{B}$

$= A \oplus B$

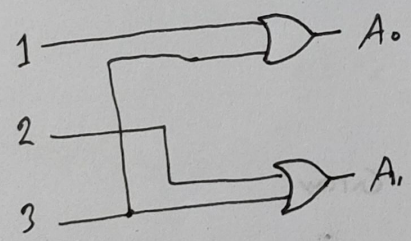


L-15 / 22.03.2023

✱ 2 bit or (1-of-4) decoder:

	Binary Inputs A_1	A_0	Decoding Function		Outputs (Active Low)				Active High			
0	0	0	$\bar{A}_1$	$\bar{A}_0$	0	1	1	1	1	0	0	0
1	0	1	$\bar{A}_1$	A_0	1	0	1	1	0	1	0	0
2	1	0	A_1	$\bar{A}_0$	1	1	0	1	0	0	1	0
3	1	1	A_1	A_0	1	1	1	0	0	0	0	1
					NAND Gate				AND Gate			

✱ Encoder



✱ Gray Code