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CSE260

TOPIC NAME : Digital Logic Design

DAY :

TIME : DATE : 9/2/25

computer high and low voltage বুঝতে পারে।

Binary → Bit = Binary Digit

1 0

Base = 2

1 bit = $\boxed{0/1}$ → $2 = 2^1$

2 bits = $\boxed{0/1}$ $\boxed{0/1}$ → 00, 01, 10, 11 } $4 = 2^2$

3 bits = $\boxed{0/1}$ $\boxed{0/1}$ $\boxed{0/1}$ → 000, 001, 010, 011, 100, 101, 110, 111 ] $8 = 2^3$

→ $2^N$

→ $Base^N$

Ternary

Trit = Ternary Digit

→ 0
→ 1
→ 2

1 trit = $\square$ → 3

2 trits = $\square\square$ → 9

3 trits = $\square\square\square$ → 27

] $3^N$ = $Base^N$

Base = 3

For M values, $\lceil \log_2 M \rceil$ bits are needed

GOOD LUCK

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Base = 8 → 0 to 7

0 to (base - 1)

$$\overset{3}{1}\ \overset{2}{2}\ \overset{1}{3}\ \overset{0}{4}$$ 0 → position

$4 \times 10^0 = 4$ 0 → position

$3 \times 10^1 = 30$

$2 \times 10^2 = 200$

$1 \times 10^3 = 1000$

1234

$$\overset{3}{1}\ \overset{2}{2}\ \overset{1}{3}\ \overset{0}{4}\ .\ \overset{-1}{5}\overset{-2}{6}\ \overset{-3}{7}\ \overset{-4}{8}$$

Hexadecimal

0
⋮
9
10 → A
11 → B
12 → C
13 → D
14 → E
15 → F

single digit

$(9\,12)_{16} \neq (9C)_{16}$

this represent 12

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# Base-R to Decimal conversion

Base-R to Base-N | $(1023)_7 = (?)_9$

(i) Base-R ↓ Decimal — $(1023)_7$ ↓ $(360)_{10}$

(ii) ↓ Base-N — ↓ $(440)_9$

## Base R to Decimal

$(1101.101)_2 = (?)_{10}$

$$\overset{3}{1}\ \overset{2}{1}\ \overset{1}{0}\ \overset{0}{1}\ .\ \overset{-1}{1}\ \overset{-2}{0}\ \overset{-3}{1}$$

$= 1\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0$
$+ 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

$= (13.625)_{10}$

$(1023)_7$

1 0 2 3

$= 1\times7^3 + 0\times7^2 + 2\times7^1 + 3\times7^0$

$= 343 + 0 + 14 + 3$

$= (360)_{10}$

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## Decimal to Base - N

$(43.3125)_{10} = (?)_2$

| | | |
|---|---|---|
| 2 | 43 | |
| 2 | 21 | 1 |
| 2 | 10 | 1 |
| 2 | 5 | 0 |
| 2 | 2 | 1 |
| 2 | 1 | 0 |
| | 0 | 1 |

$(43)_{10} = 101011$

$(0.3125)_{10} = (?)_2$

$0.3125 \times 2 = \underline{0}.625$

$0.625 \times 2 = \underline{1}.25$

$0.25 \times 2 = \underline{0}.50$

$0.50 \times 2 = \underline{1}.00$

$(0.3125)_{10} = (0.0101)_2$

$(43.3125)_{10} = (101011.0101)_2$

MSB → Most significant Bit

LSB → Least significant Bit

3(MSB), 2, 1, 0(LSB)

1 0 1 0

4 3 (M, L)

change করলে যদি 1st digit LSB বলে,

4 3 (L, M)

= 3 4

তখন 34 কে ভাগ করতে হবে।

$(360)_{10} \rightarrow (?)_9$

$$\begin{array}{r|l} 9 & 360 \\ \hline 9 & 40 - 0 \\ \hline 9 & 4 - 4 \\ \hline & 0 - 4 \end{array} \uparrow$$

$(360)_{10} = (440)_9$

* $(1011.10110)_2 = (?)_8$

| Oct | — | Bin |
|---|---|---|
| 0 | | 000 |
| 1 | | 001 |
| 2 | | 010 |
| 3 | | 011 |
| 4 | | 100 |
| 5 | | 101 |
| 6 | | 110 |
| 7 | | 111 |

$\overset{\leftarrow}{} \quad \overset{\rightarrow}{}$

$\underbrace{001}_{1}\underbrace{011}_{3}.\underbrace{101}_{5}\underbrace{100}_{4}$

$= (13.54)_8$

$(13.54)_8 = (?)_2$

001 011. 101 100

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## Addition

$$\begin{array}{r} 93 \\ 92 \\ \hline 185 \end{array} \qquad \begin{array}{r} 99 \\ +\ 98 \\ \hline 197 \end{array}$$

$x = 17$

$$\begin{array}{r|l} 10 & 17 \mid 1 \\ & 10 \\ \hline & 7 \end{array}$$

$$\begin{array}{r|l} 10 & 19 \mid 1 \\ & 10 \\ \hline & 9 \end{array}$$

if ($x \geq$ Base):
    Division
else:
    ans

$$\begin{array}{r} (10110)_2 \\ (11111)_2 \\ \hline 110101 \end{array}$$

$$\begin{array}{r|l} 2 & 2 \mid 1 \\ & 2 \\ \hline & 0 \end{array}$$

$$\begin{array}{r|l} 2 & 3 \mid 1 \\ & 2 \\ \hline & 1 \end{array}$$

## Sub

$$\begin{array}{r} 9\,2\,3^{13} \\ -\ 2\,8_{9}\,9 \\ \hline 6\,3\,4 \end{array}$$

$^{13} \rightarrow$ base ধার করেছি

$9 \rightarrow$ 1 যোগ

$$\begin{array}{r} 13 \\ -9 \\ \hline 4 \end{array} \qquad \begin{array}{r} 12 \\ -9 \\ \hline 3 \end{array}$$

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$$
\begin{array}{r}
 {\scriptstyle 0+2\ \ 1+2\ \ 0+2} \\
(1\,0\,1\,0\,1\,1)_2 \\
-\ (0\,1\,1\,1\,1\,0)_2 \\
{\scriptstyle 0+1\ \ 1+1\ \ 1+1} \\
\hline
0\,0\,1\,1\,0\,1
\end{array}
$$

## Multiplication

$$
\begin{array}{r}
(2\ A\ 3\ C)_{16} \\
(B\ 7)_{16} \\
\hline
1\ 2\ 7\ A\ 4 \\
1D\ 0\ 9\ 4\ 0 \\
\hline
1\ E\ 3\ 0\ E\ 4
\end{array}
$$

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

$$
\begin{array}{l}
16 \mid 132 \mid 8 \\
\quad 128 \\
\quad \overline{\quad 4} \\
16 \mid 41 \mid 2 \\
\quad 32 \\
\quad \overline{\quad 9} \\
16 \mid 112 \mid 7 \\
\quad 112 \\
\quad \overline{\quad 0} \\
16 \mid 29 \mid 1 \\
\quad 16 \\
\quad \overline{\ 13} \rightarrow D
\end{array}
$$

## Division

$$
\begin{array}{r|l}
110 & 1011101 \;|\; 0001111 \\
 & -0 \\
\hline
 & 10 \\
 & -0 \\
 & 101 \\
 & -0 \\
 & 1011 \\
 & -110 \\
 & 01011 \\
 & -110 \\
 & 01010 \\
 & -110 \\
 & 01001 \\
 & -110 \\
\end{array}
$$

= 1111 → Quotient

= 11 → remainder

110 > 1
110 > 10
110 > 101
110 < 1011
110 < 1011
110 < 1010
110 < 1001

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## Base 5

$$
\begin{array}{r|l|l}
321 & 234102 & 000400 \\
\end{array}
$$

-0
23
-0
234
-0
2341
-2334
00020
-0
202
-0
202

↳ Remainder

↳ 400 = 940

321 > 2
321 > 23
321 > 234
321 > 20
321 > 202

321 × 0 = 0
321 × 1 = 321
321 × 2 = 1142
321 × 3 = 2013
321 × 4 = 2334

321
× 3
2013

5 | 6 | 1
5
1

5 | 10 | 2
10
0

321
× 4
2334

5 | 8 | 1
5
3

5 | 13 | 2
10
3

BCD → Binary Coded Decimal

3 4 5 0

↓ ↓ ↓ ↓

0011 0100 0101 0000

$(3450)_{10} = (?)_{BCD}$

$= (0011010001010000)_{BCD}$

$(\underbrace{00\,10}_{2}\underbrace{0101}_{5}\underbrace{1111}_{})_{BCD} = (?)_{10}$

↓ unused form

so error

## Decimal to Excess N

step 1 : Decimal digit + N

step 2 : Now find the binary of (Decimal digit + N)

$(3)_{10} = (?)_{ex-5}$

$3 + 5 = 8 = 1000$

$(3)_{10} = (1000)_{ex-5}$

$(321)_{10} = (?)_{ex5}$

| 3 | 2 | 1 |
|---|---|---|
| +5 | +5 | +5 |
| 8 | 7 | 6 |
| ↓ | ↓ | ↓ |
| 1000 | 0111 | 0110 |

$(321)_{10} = (1000\ 0111\ 0110)_{ex5}$

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# Signed Number Representation

(i) sign & magnitude
(ii) 1s complement
(iii) 2s complement

} 3 টা system এর positive number represent করার process same

Represent +4 in S & M form :

4 = 100
+4 = 0100
-4 = 1100
sign

{ +ve হলে 0, -ve হলে 1.

$(0100)_{S\&M} = (?)_{10}$
sign

$= (+4)_{10}$

Represent +4 in 6 bit, S&M form.

4 = 100
+4 = 0100
000 100
-4 = 1100
100 100

{ 6 bit বললে বাকি 2 bit sign bit এর পর বসাবো।

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Represent +4 in 1s complement form.

$4 = 100$

$+4 = 0100$

$+4 = 000100 \rightarrow$ 6 bit

Represent −4 in 1s complement form (6 bit)

$4 = 100$

$+4 = 0100$

$= 000100$

$-4 = (111011)_{1s}$

* $(111011)_{1s} = (?)_{10}$

↳ −ve

$(000100) = (-4)_{10}$

↳ −ve

−16 in 10 bit 1s complement form

$16 = 10000$

$+16 = \overbrace{00000}^{\text{copy}}10000$

$\cancel{= 0000001111}$

$= 1111101111$

$\cancel{(-16) = 0000001111}$

$(-16) = (1111101111)_{1s}$

Represent +4 in 6 bit 2s com form

$4 = 100$

$+4 = 0100$

$= (000100)_{2s}$

{ 2s com এ প্রথমে 1s com এ নিয়ে 1 add করতে।

111011
+1

$-4 = (111100)_{2s}$

*

$(111100)_{2s} = (?)_{10}$

↳ -ve

{ i) identify +ve/-ve
(ii) again 2s complement

000011
+1
000100

$= -4$

Add +12 with +13 in 1s comp. form

↳ 13 + 12

$13 = 1101$

$+13 = 01101$ ✓

$12 = 1100$

$+12 = 01100$ ✓

01101
+01100
11001

subtract 12 from 13 in 1s comp. form

↳ $13 - 12 = 13 + (-12)$

$13 = 1101$

$+13 = 01101$

$12 = 1100$

$+12 = 01100$

$-12 = 10011$

$$
\begin{array}{r}
01101 \\
10011 \\
\hline
100000
\end{array}
$$

↳ extra carry

$$
\begin{array}{r}
+1 \\
\hline
00001
\end{array}
$$

↳ answer

1s comp এ extra carry আসলে তাকে ans এর সাথে add করে

sub 12 from 13 in 2s comp. form

$13 - 12 = 13 + (-12)$

$13 = 1101$

$+13 = 01101$

$12 = 1100$

$+12 = 01100$

$$
\begin{array}{r}
10011 \\
+1 \\
\hline
\end{array}
$$

$-12 = (10100)_{2s}$

$$
\begin{array}{r}
01101 \\
10100 \\
\hline
100001
\end{array}
$$

↳ extra carry

2s comp এ carry বাদ দিয়ে দি

ans = 00001

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## Overflow

### Addition

Add two same signed number

~~is (answer~~

$(+A) + (+B) = +$ then $OF = 0$

$= -$ then $OF = 1$

$(-A) + (-B) = -$ then $OF = 0$

$(-A) + (-B) = +$ then $OF = 1$

২টা same sign এর number add করলে ঐ sign না এসে অন্যটা আসলে OF হয়।

2. ২টা same sign এর number substract করলে overflow হয় না

$\left.\begin{array}{l} +A - +B \\ -A - -B \end{array}\right\}$ never overflow

3. ২টা different sign এর number যোগ করলে overflow হয়না

$\left.\begin{array}{l} -A + +B \\ +A + -B \end{array}\right\}$ never overflow

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Add 12 with 13 in 1's comp.

Check if overflow or not, justify.

$$+12 = 01100$$
$$+13 = 01101$$

11001

yes, overflow. ↳ diff sign

According to the rule: add two same signed number if answer has different sign represents overflow.

* Divide $(ABC)_{16}$ by $(D)_{16}$.

D | ABC | D3 → Quo

0A

AB

− A9

2C

− 27

5 → Remainder

D×0 = 0

D×1 = D

D×2 = ~~26~~ 1A

D×3 = ~~39~~ 27

D×4 = ~~52~~ 34

D×5 = 41

D×6 = 4E

D×7 = 5B

D×8 = 68

D×9 = 75

D×A = 82

D×B = 8F

D×C = 9C

D×D = A9

D×E = B6

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## Binary Logic

Logic operation : and, or, not

AND, OR, NOT - Basic gate

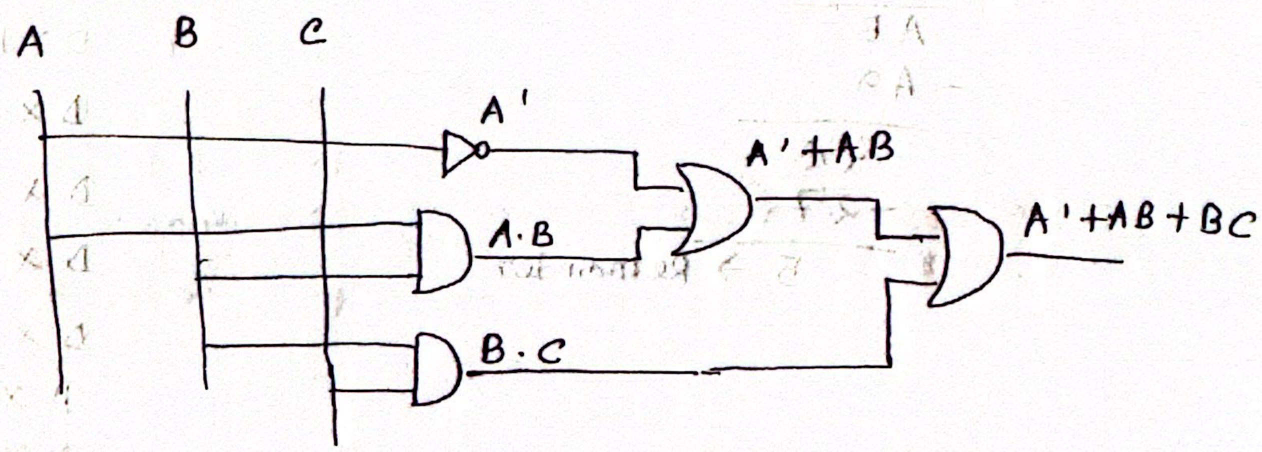
NAND, NOR - Universal gate

AND Gate : N টা input থাকলে N টা 1 হলে output 1 হবে এবং 1 টা 0 হলে output 0 হবে।

OR Gate : N টা input থাকলে 1 টা 1 হলে output 1 হবে।

* Draw the circuit Diagram of the function :

$F(A,B,C) = A' + AB + BC$



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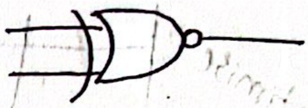
XOR → $A \oplus B$


$= A'B + AB'$

N টা input থাকলে N টা same হয় , তাহলে output 0 হবে ।

XNOR → $A \odot B$

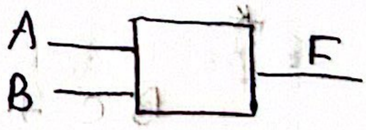
$= AB + A'B'$

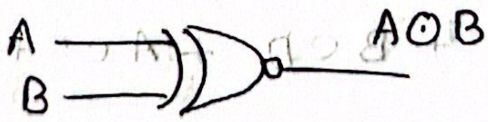


N টা input থাকলে N টা bit same হলে, output 1।

Draw the circuit diagram of a device that compares two 1 bit numbers, if both are same output should be 1, else 0.

| A | B | F |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |



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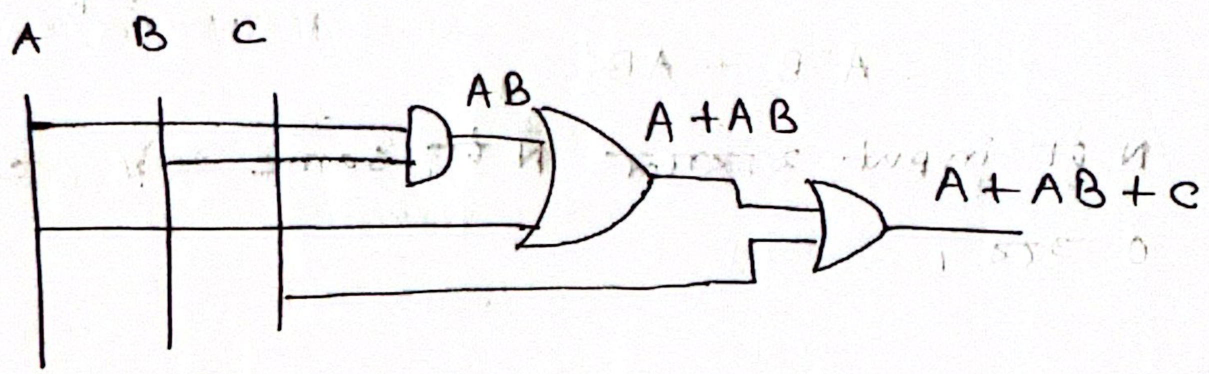
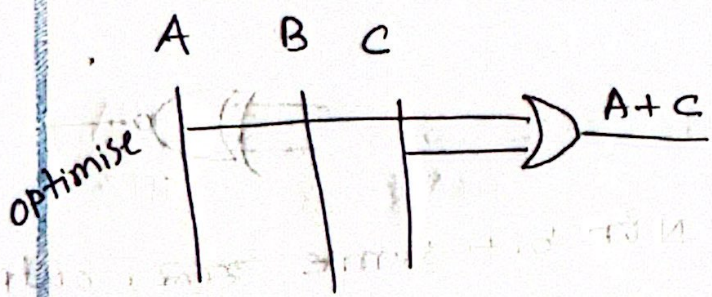
$A + AB + C = A(B+1) + C = A + C$




i) Boolean algebra
ii) k - map
iii) Tabulation

} function simplified

*

$BC + AC' + AB + BCD$

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

$\Rightarrow BC + BCD + AC' + AB$

$\Rightarrow BC(1+D) + AC' + AB$

$\Rightarrow \underbrace{BC}_{A} + \underset{B}{A}\, \underset{C}{C'} + AB$

$\Rightarrow (BC + A) \cdot (BC + C') + AB$

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$\Rightarrow (A+B)(A+C)(B+C')(\cancel{C+C'}^{\,1}) + AB$

$\Rightarrow (A+B)(A+C)(B+C') + AB$

Complementing a function

1. Take dual of the function
2. complement each literals

$F = XY + Y'Z$

$F' = (X+Y)(Y'+Z)$

$= (X'+Y')(Y+Z')$

$(a+b)' = a' \cdot b'$

$(a \cdot b)' = a' + b'$

De-morgan (Alternative)

$F = XY + Y'Z$

$F' = (\underbrace{XY}_{a} + \underbrace{Y'Z}_{b})'$

$= (\underset{a}{X}\underset{b}{Y})' \, (\underset{a}{Y'}\underset{b}{Z})'$

$= (X'+Y')(Y+Z')$

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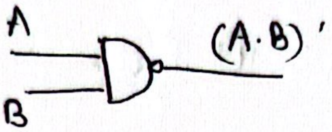
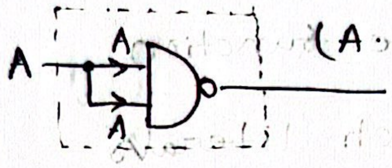
## NAND

### NOT

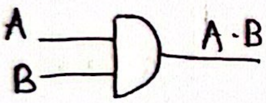
NOT using NAND

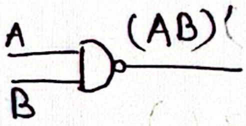



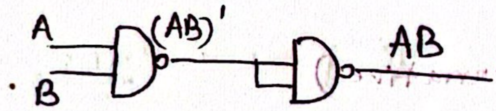




### AND

AND using NAND

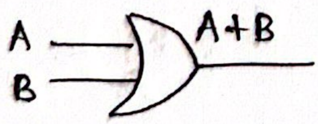


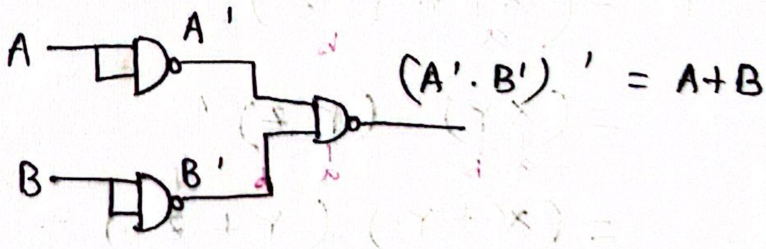




### OR

OR using NAND




$(A' \cdot B')'$

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

$= A + B$

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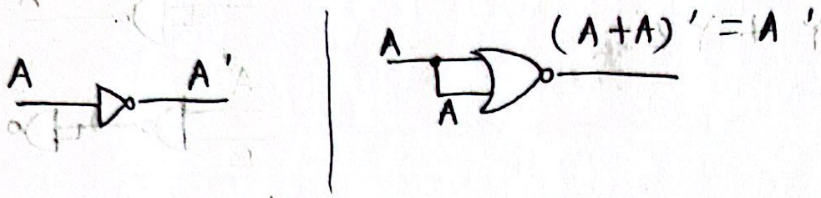
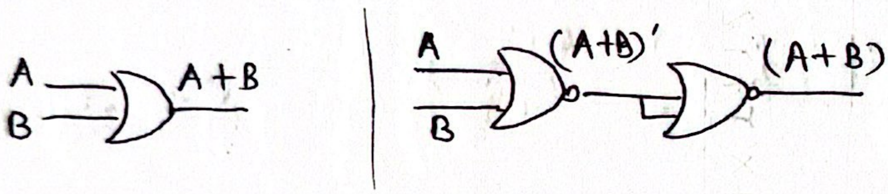
## NOR

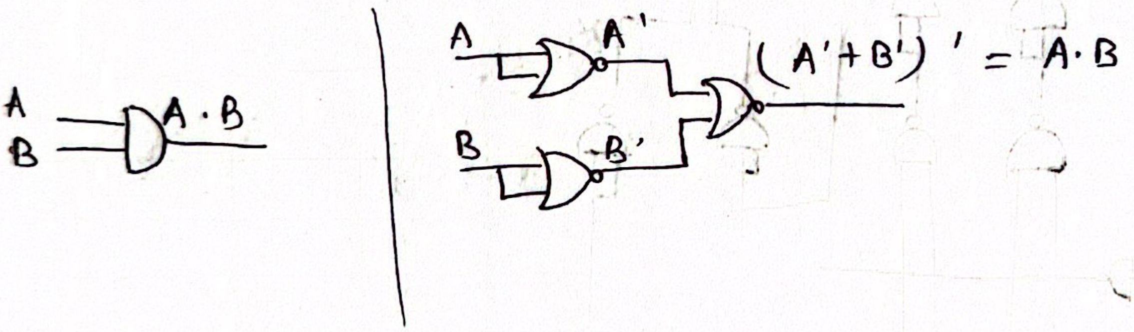
Not using NOR




OR using NOR




AND using NOR




$(A' + B')'$

a b

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

$= A \cdot B$

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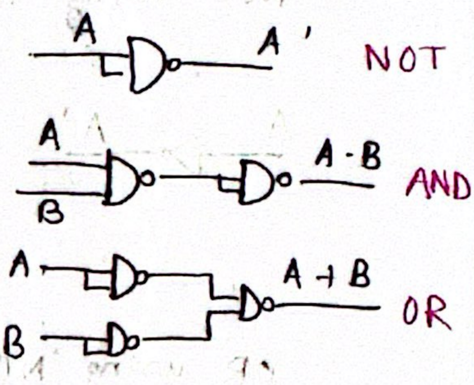
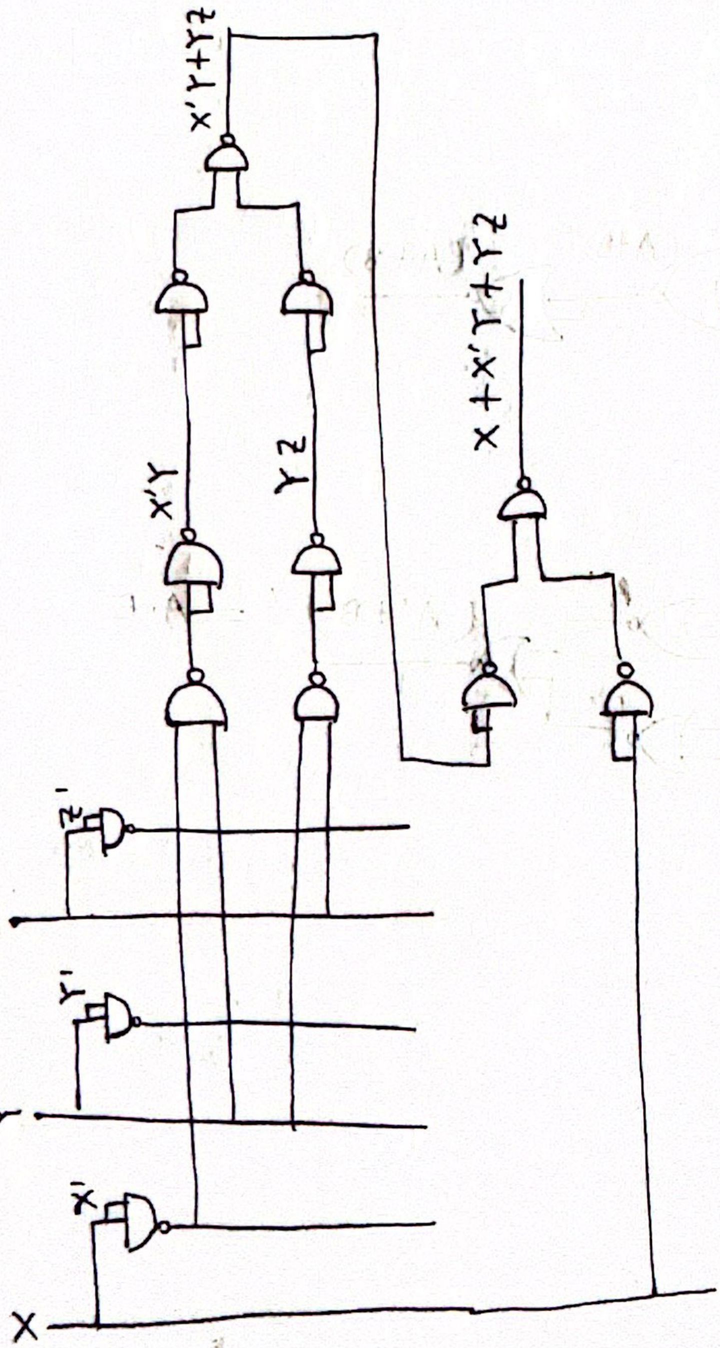
Draw the circuit Diagram of the Following Function using NAND gate(s) only.

$F = X + X'Y + YZ$




GOOD LUCK

S.O.P ⇒ Sum of Product (·) + (·)

↳ min term → 1

P.O.S ⇒ Product of Sum (+) · (+)

↳ max term → 0

Min → 0 → A' ;

1 → A

Max → 0 → A

1 → A'

$F(A,B,C) = AC + BA$ → SOP

$F(A,B,C) = (A+B)\cdot(C'+B')$ → POS

input → output

| | A | B | C | F |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 → max term |
| 2 | 0 | 1 | 0 | 1 → min term |
| 3 | 0 | 1 | 1 | 1 |
| 4 | 1 | 0 | 0 | 0 |
| 5 | 1 | 0 | 1 | 0 |
| 6 | 1 | 1 | 0 | 1 |
| 7 | 1 | 1 | 1 | 1 |

$F(A,B,C) = \Sigma(2,3,6,7)$

$F(A,B,C) = \Pi(0,1,4,5)$

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## SOP

$F(A,B,C) = \Sigma(2,3,6,7)$

1 → A
0 → A'

010 → $A'BC'$

011 → $A'BC$

110 → $ABC'$

111 → $ABC$

$F(A,B,C) = A'BC' + A'BC + ABC' + ABC$

Canonical S.O.P

প্রত্যেকটি term এ প্রত্যেকটি variable present থাকলে তাকে canonical S.O.P বলে। (A, B, C)

## POS

$F(A,B,C) = \Pi(0,1,4,5)$

0 → A
1 → A'

000 → $A+B+C$

001 → $A+B+C'$

100 → $A'+B+C$

101 → $A'+B+C'$

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

000 → 0, 001 → 1, 100 → 4, 101 → 5

max → decimal 0 1 4 5

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$F(A, C, B) = \Sigma(2, 3, 6, 7)$

Figure out the function in S.O.P Form.

$$\Sigma(2, 3, 6, 7)$$

$$\begin{array}{cccc} 010 & 011 & 110 & 111 \\ \downarrow & \downarrow & \downarrow & \downarrow \\ A'CB' & A'CB & ACB' & ACB \end{array}$$

$$F(A, C, B) = A'CB' + A'CB + ACB' + ACB$$

Note: প্রথমে sequence maintain করবো, তারপর value বের করবো।

* $F(A, C, B) = A + B'C$ [canonical SOP form এ নেই, so আগে canonical SOP বানিয়ে নিবো]

Boolean logic $A + A' = 1$

$$= A(\overset{1}{C + C'})(\overset{1}{B + B'}) + (\overset{1}{A + A'})CB'$$

$$= (AC + AC')(B + B') + ACB' + A'CB'$$

$$= ACB + ACB' + AC'B + AC'B' + ACB' + A'CB'$$

$$\begin{array}{cccccc} 111 & 110 & 101 & 100 & 110 & 010 \end{array}$$

$$= \Sigma(7, \underline{6}, 5, 4, \underline{6}, 2)$$

$$= \Sigma(2, 4, 5, 6, 7)$$

$$= \Pi(0, 1, 3)$$

{দুটো term same হলে 1 টা নিবো এবং serial by লিখবো

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$$F(A, C, B) = \pi(0, 1, 3)$$

$$\begin{array}{ccc} 0 & 1 & 3 \\ \downarrow & \downarrow & \downarrow \\ 000 & 001 & 011 \end{array}$$

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

* $\boxed{SOP \rightarrow POS}$

Process :
1. distribute law apply করতে হবে

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

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

$$= (A + \overset{\rightarrow 0}{CC'} + B') \cdot (A + C + \overset{\rightarrow 0}{BB'})$$

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

$$\begin{array}{cccc} (A+C+B') & (A+C'+B') & (A+C+B) & (A+C+B') \\ \downarrow & \downarrow & \downarrow & \downarrow \\ 001 & 011 & 000 & 001 \end{array}$$

$$= \pi(1, 3, 0, 1)$$

$$= \pi(0, 1, 3)$$

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**k-map :** k-map is a visual method that is used to simplify boolean function.

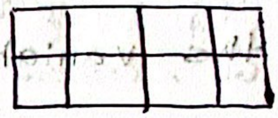
**Step 1 :** Find how many variables are used in the function.

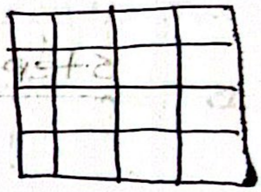
⇒ n → 1, 2, 3, 4, ...

**Step 2 :** Using the value of n find size of the k-map
↓
how many cells

size = $2^n$

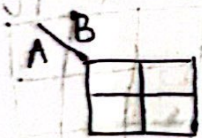
for 2 variables; $2^2 = 4$ for 3; $2^3 = 8$ for 4 var; $2^4 = 16$



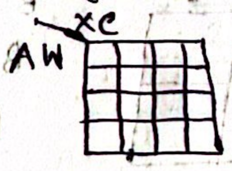


**Step 3 :** Position the variables

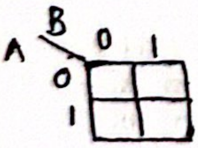
F(A, B) = __ F(B, D, A) = __ F(A, W, X, C) = __

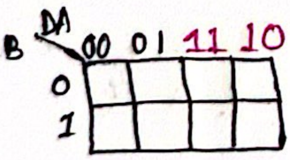




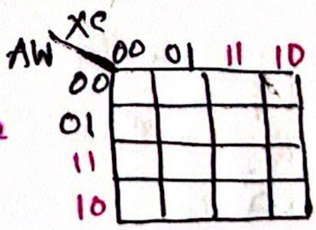



**Step 4 :** Number the rows and columns




↘ 1 bit difference



**Step 5 :** Number the cells according to the row and column numbers.

| | 0 | 1 |
|---|---|---|
| 0 | 00→0 | 01→1 |
| 1 | 10→2 | 11→3 |

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 0 | 000 →0 | 001 →1 | 011 →3 | 010 →2 |
| 1 | 100 →4 | 101 →5 | 111 →7 | 110 →6 |

| | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 1 | 3 | 2 |
| 01 | 4 | 5 | 7 | 6 |
| 11 | 12 | 13 | 15 | 14 |
| 10 | 8 | 9 | 11 | 10 |

* K-maps are solvable in 2 modes.
- → min term
- → max term

We will only work in min term mode.

**Step 6 :** Set the variables according to the row and column combinations.

| A \ B | B' 0 | B 1 |
|---|---|---|
| A' 0 | | |
| A 1 | | |

| B \ DA | D'A' 00 | D'A 01 | DA 11 | DA' 10 |
|---|---|---|---|---|
| B' 0 | | | | |
| B 1 | | | | |

| AW \ XC | x'c' 00 | x'c 01 | xc 11 | xc' 10 |
|---|---|---|---|---|
| A'W' 00 | | | | |
| A'W 01 | | | | |
| AW 11 | | | | |
| AW' 10 | | | | |

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# F = Target is to find the min terms.

i) $F(A,B,C) = AB' + BC + C$ ] → canonical SOP form → min term

ii) $F(A,B,C) = ABC + A'BC + A'B'C + A'B'C'$ ] → Already in canonical SOP form → so just find the min term.

iii) $F(A,B,C) = \Sigma(0,1,2,3)$ ] → min terms are already given.

iv) $F(A,B,C) = \Pi(1,2,3)$ ] → max terms given; Find min terms.

<u>Step 7</u>: Go through each cells. If the cell's number is one of your min term, write 1 in that cell.

$F(A,B) = \Sigma(0,1)$

| | |
|---|---|
| 1 (0) | 1 (1) |
| (2) | (3) |

$F(B,D,A) = \Sigma(0,4,1,3)$

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | |
| 1 | | | |

$F(A,W,X,e) = \Sigma\, 0,1,3,4,5,7,10,11,14,1$

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | |
| 1 | 1 | 1 | |
| | | 1 | 1 |
| | | 1 | 1 |

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F(A, B, C, D) =

lab { Truth table
min table
k map
→ implement

| AB \ CD | C'D' | C'D | CD | CD' |
|---|---|---|---|---|
| A'B' | 0 | 1 | 3 | 2 |
| A'B | 4 | 5 | 7 | 6 |
| AB | 12 | 13 | 15 | 14 |
| AB' | 8 | 9 | 11 | 10 |

Step 8: Now, we'll group the 1's.

Grouping Rules:

i) Group the adjacent 1's in groups of 2, 4, 8, 16 and so on [$2^n$]

ii) Take maximum number of 1 is possible to form a group.

iii) You can cover a 1 multiple times only if that covered '1' can help another uncovered '1' to get covered.

iv) Our target is to group all the 1's

Step 9: For each group find the product term.

Step 10: Now OR the product terms. If one product term keep as it is.

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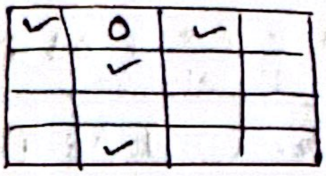
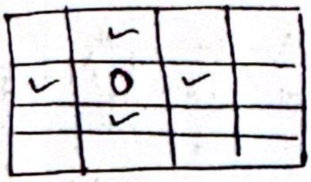
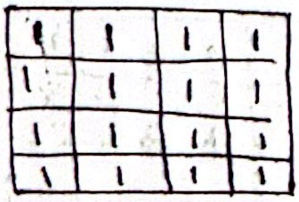


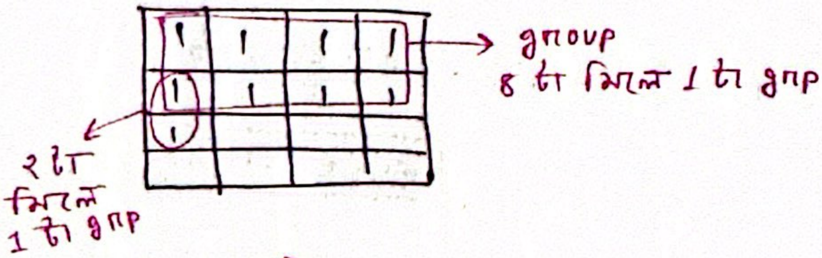
adjacent cell

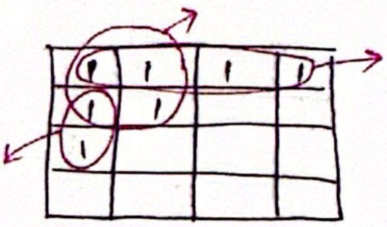


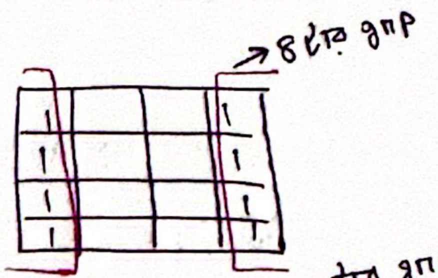
adjacent cell

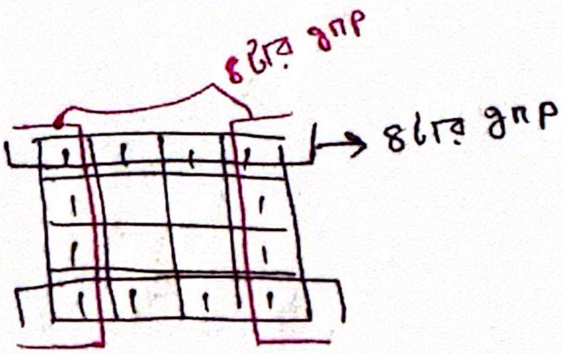


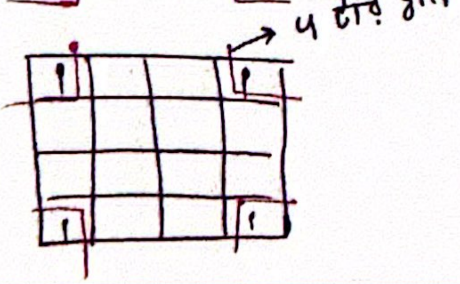
F = 1





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don't care

$F(A, B, C, D) = \Sigma(0, 1, 2, 3, 5, 7) + d(4, 6, 11, 12)$

| AB \ CD | C'D' | C'D | CD | CD' |
|---|---|---|---|---|
| A'B' | 1 ₀ | 1 ₁ | 1 ₃ | 1 ₂ |
| A'B | X ₄ | 1 ₅ | 1 ₇ | X ₆ |
| AB | X ₁₂ | 13 | 15 | 14 |
| AB' | 8 | 9 | X 11 | 10 |

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | 1 |
| | 1 | 1 | |
| | | | |
| | | | |

A'B'

A'D

$F = A'B' + A'D$

শুধু don't care এর grp বানানো যাবে না।

grp যদি বড় করা যায়, তাহলে don't care কে add করবো।

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | 1 |
| X | 1 | 1 | X |
| | | | |
| | | | |

→ A' → most simplified

$F = A'$

| | | | |
|---|---|---|---|
| 1 | 1 | 1 | |
| X | | | |
| | | | |
| | | | |

Important lecture for Mid

TOPIC NAME: DAY: TIME: DATE: 4 / 3 / 25

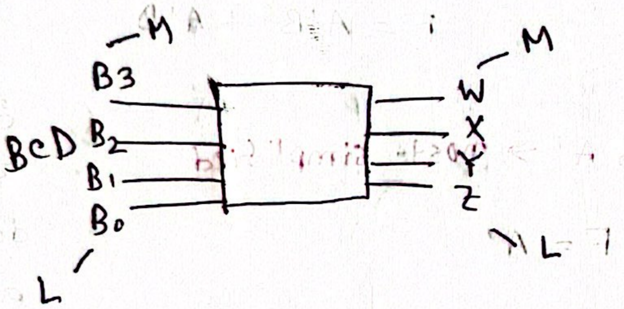
**Example 1:** Design and draw the circuit diagram of BCD to excess - 3 code converter.

BCD to unique digit = 9

সর্বোচ্চ bit = 4

So input = 4

9 এর excess 3 = 9+3
= 12
↓
4 digit
↓
4 output




Input → 0000

output (excess 3) = 0+3 = 3

= 0010 (3 এর binary)

Input → 10 (not valid

Output → don't care

1 Output → 1 k-map

যতগুলো output এর column, ততগুলো k-map

k-map এ কতগুলো ঘর হবে সেটা depend করে input এর উপর।

K-map carries 50%
in midterm

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$W = \Sigma(5, 6, 7, 8, 9) + d(10, 11, 12, 13, 14, 15)$

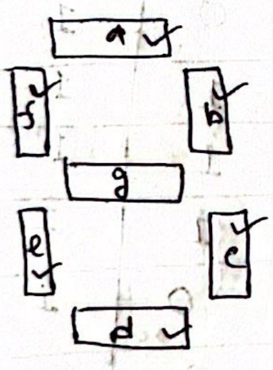
| $B_3B_2$ \ $B_1B_0$ | $B_1'B_0'$ | $B_1'B_0$ | $B_1B_0$ | $B_1B_0'$ |
|---|---|---|---|---|
| $B_3'B_2'$ | 0 | 1 | 3 | 2 |
| $B_3'B_2$ | 4 | 1 (5) | 1 (7) | 1 (6) |
| $B_3B_2$ | X (12) | X (13) | X (15) | X (14) |
| $B_3B_2'$ | 1 (8) | 1 (9) | X (11) | X (10) |

→ $B_0B_2$

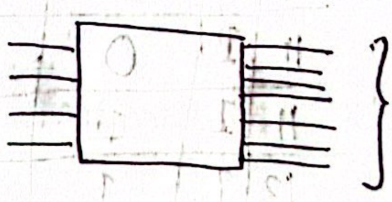
→ $B_2B_1$

→ $B_3$

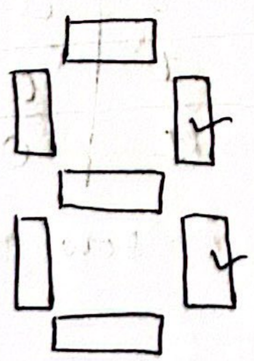
Example 2: 7 segment display board.




= 0



7 output



= 1

## Practice Problem

K-Map scenario based practice problem

| | W | X | Y | Z | A | B |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 |
| 2 | 0 | 0 | 1 | 0 | 1 | 1 |
| 3 | 0 | 0 | 1 | 1 | 0 | 1 |
| 4 | 0 | 1 | 0 | 0 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 | 1 | 1 |
| 6 | 0 | 1 | 1 | 0 | 1 | 0 |
| 7 | 0 | 1 | 1 | 1 | 0 | 1 |
| 8 | 1 | 0 | 0 | 0 | 1 | 1 |
| 9 | 1 | 0 | 0 | 1 | 1 | 1 |
| 10 | 1 | 0 | 1 | 0 | 1 | 1 |
| 11 | 1 | 0 | 1 | 1 | 0 | 1 |
| 11 | 1 | 1 | 0 | 0 | 0 | 0 |
| 13 | 1 | 1 | 0 | 1 | 0 | 0 |
| 14 | 1 | 1 | 1 | 0 | 1 | 0 |
| 15 | 1 | 1 | 1 | 1 | 1 | 0 |

presence of UV → $y = 1$

low humidity → $z = 0$

accompanied by → and

high temp → $W = 1$

with → and

normal oxygen level → $x = 1$

TOPIC NAME: DAY: TIME: DATE: / /

1. $A = Y(W \cdot X + Z')$

2. UV light absent $\rightarrow Y = 0$

then $\rightarrow$ and

abnormal level of oxygen $\rightarrow X = 0$

high humidity $\rightarrow Z = 1$

With $\rightarrow$ and

low temp $\rightarrow W = 0$

$A = Y'(X' + ZW')$

Merge:

$$A = Y(WX + Z') + Y'(X' + ZW')$$

3. oxygen level is not normal $\rightarrow X' = 0$

high humidity $\rightarrow Z = 1$

with $\rightarrow$ and

low temperature $\rightarrow W = 0$

$B = X' + Z \cdot W'$

$= \Sigma(0, 1, 2, 3, 5, 7, 8, 9, 10, 11)$

GOOD LUCK

TOPIC NAME: DAY: TIME: DATE: / /

Truth table fill up করার approach:

i) Directly insert combinations in the boolean equation and find the corresponding outputs.

ii) Find canonical SOP or POS then plug in the min/max terms accordingly in the truth table.

$$A = Y(WX + Z') + Y'(X' + ZW')$$

$$= WXY + YZ' + X'Y' + W'Y'Z$$

$$= WXY(Z + Z') + (W + W')(X + X')YZ' + (W + W')X'Y'(Z + Z') + W'Y'Z(X + X')$$

$$= \overset{1111}{WXYZ} + \overset{1110}{WXYZ'} + \overset{1110}{WXYZ'} + \overset{1010}{WX'YZ'} + \overset{0110}{W'XYZ'}$$

$$+ \overset{0010}{W'X'YZ'} + \overset{1001}{WX'Y'Z} + \overset{1000}{WX'Y'Z'} + \overset{0001}{W'X'Y'Z}$$

$$+ \overset{0000}{W'X'Y'Z'} + \overset{0101}{W'XY'Z} + \overset{0001}{W'X'Y'Z}$$

$$= \Sigma(15, 14, 10, 6, 2, 9, 8, 1, 0, 5)$$