

DLD

Number System: Computer মূহুর্তা Binary (0,1) language ব্যক্তি।

- Binary (0,1)
(2)
- Octal (0....7)
(8)
- Decimal (0....9)
(10)
- Hexa-decimal (0....F)
(16)

Conversion:

Bin
Dee / oct
Hex

$$(46.6875)_{10} = (?)_2 = (?)_8 = (?)_{16}$$

Soln:

$$\begin{array}{r} 2 \overline{) 46} \\ \underline{23} \\ 2 \overline{) 23} \\ \underline{11} \\ 2 \overline{) 11} \\ \underline{5} \\ 2 \overline{) 5} \\ \underline{2} \\ 1 \overline{) 2} \\ \underline{1} \\ 2 \overline{) 1} \\ \underline{0} \\ 0 - 1 \end{array}$$

$$\begin{array}{r} 0.6875 \\ \times 2 \\ \hline 1.375 \\ \times 2 \\ \hline 0.75 \\ \times 2 \\ \hline 1.5 \\ \times 2 \\ \hline 1.00 \end{array}$$

$$(46.6875)_{10} = (101110.1011)_2$$

same ভাবে বাকি Number system এর ক্ষেত্রে Base দ্বারা ভাগ করে করতে হবে। (পূর্ণ অংশের ক্ষেত্রে আর দশমিকের দশকে গুন করতে হবে।)

5-base श्रम $\rightarrow (0 \dots 4)$ मरुतु number श्रव 1

Bin $\rightarrow$
oct $\rightarrow$ Dec $\quad \underline{\text{Qm.}} \quad (1101.11)_2 = (?)_{10}$
hex $\rightarrow$

Soln.

$$1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \cdot 1 \times 2^{-1} + 1 \times 2^{-2}$$

$$= 8 + 4 + 1 \cdot \frac{1}{2} + \frac{1}{4}$$

$$= 13.75 \text{ (Ans)}$$

Qm. $(123.540)_8 = (?)_{10}$

Soln.

$$1 \times 8^2 + 2 \times 8^1 + 3 \times 8^0 \cdot 5 \times 8^{-1} + 4 \times 8^{-2} + 0 \times 8^{-3}$$

$$= (64 + 16 + 3 \cdot \frac{5}{8} + \frac{4}{64} + 0)$$

$$= (83.6875)_{10}$$

⊕ Binary $\rightarrow$ oct
 $\rightarrow$ Dec Done
 $\rightarrow$ Hexa

Qm. $(1001110.11101)_2 = (?)_8 = (?)_{16}$

Soln.

bin $\rightarrow 2^1$	] so octal 3bit & Hexa
oct $\rightarrow 8 = 2^3$	
hex $\rightarrow 16 = 2^4$	

decimal 4bit.

$$\overline{001001110.111010} = (116.72)_8$$

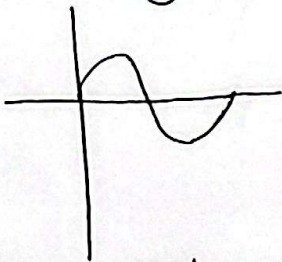
similarly 4bit নিয়ে
Hexa to binary
conversion হবে।

oct → Bin এর ক্ষেত্রে oct এর প্রত্যেকটি number কে 3bit binary তে convert করবো।

$$(2145.47)_8 = (?)_2$$

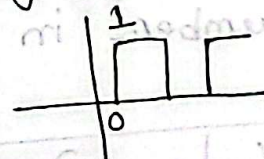
$$= (010001100101.100111)_2$$

⊕ Analog :



sinusoidal wave

Digital :



⊗ টেলিফোনে analog এবং ডিজিটাল স্কিম

Digital signal use হয়।

voice (analog) → digital → analog → then আমরা কুনডে পারি।

Binary to Hexa decimal :

$$(10011001101.11)_2 = (?)_{16}$$

$$0100 \quad 1100 \quad 1101 \quad 1100 \quad 1100 \quad 1000 \quad 1010$$

$$= (4CD.C)_{16}$$

4

C

D

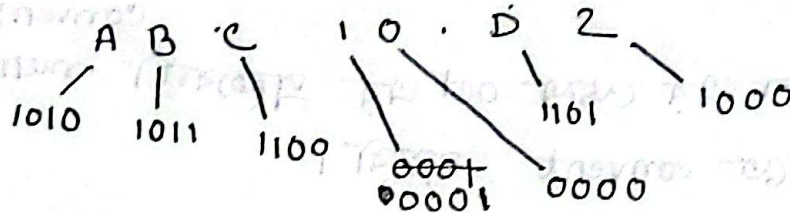
C

$$(011010110010001010)_2 = (123.123)_8$$

Hexa-to-Binary:-

0	1	2	4	8
		0	1	0

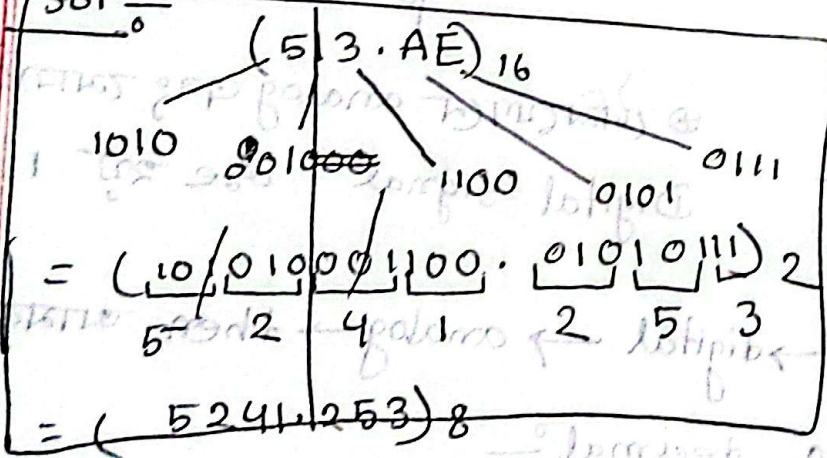
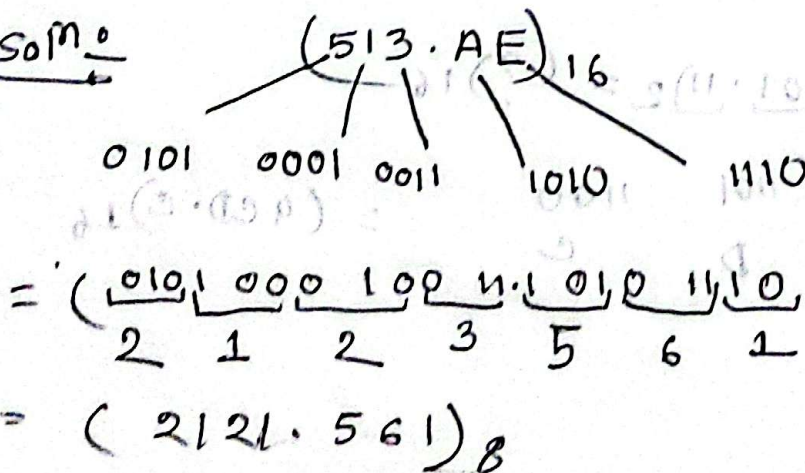
$$(ABE10.D2)_{16} = (?)_2$$

Soln

$$(1010101111001000000000.11011000)_2$$

Spring-2021:-

⑤ ⑥ Convert the following number $(513.AE)_{16}$ to a number in base-8?

SolnSoln

④ There are two numbers, $(4022)_x = (878)_y$ which is true?

① $x=y$ ② $x>y$ ③ $x<y$.

because of $x \geq 5$; $y \geq 9$

Fall-2019 Find the value of x , for when $(346)_7 = (501)_x$

Solⁿ

$$3x^2 + 4x^1 + 4x^0 = 5x^2 + 0x^1 + 1x^0$$

$$\Rightarrow 40x^3 + 4x^7 + 4 = 5x^2 + 1$$

$$\Rightarrow 147 + 28 + 4 - 1 = 5x^2$$

$$\Rightarrow 5x^2 = 178$$

$$\therefore x^2 = \frac{178}{5} \therefore x =$$

① $(ABC.F56)_{16} = ()_{10} = ()_8$

② $(46705.6)_8 = ()_{10} = ()_{16}$

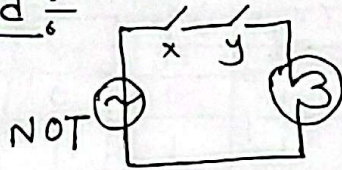
③ $(56)_8$, $(A9)_{16}$, $(65)_{10} \rightarrow$ which is largest?

Solⁿ

① $(ABC.F56)_{16}$

⊕ Logic Gate :-

And :-

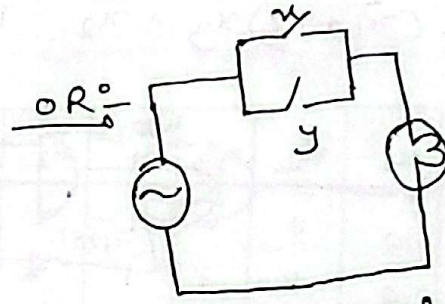


logic 0 $\rightarrow$ 0V
logic 1 $\rightarrow$ +5V

Truth table :-

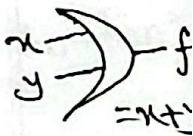
x	y	f
0	0	0
0	1	0
1	0	0
1	1	1

x y $\Rightarrow$ $f = xy$
symbol



Truth table :-

x	y	x+y
0	0	0
0	1	1
1	0	1
1	1	1



Question type :-

Problem $\rightarrow$ truth table $\rightarrow$ fn. expression

implement function.

Function to truth table :-

$$f_1 = \bar{x}_1 + x_1 x_2$$

$$f_2 = \bar{x}_1 + x_2$$

x_1	x_2	$\bar{x}_1$	$x_1 x_2$	f_1	f_2
0	0	1	0	1	1
0	1	1	0	1	1
1	0	0	0	0	0
1	1	0	1	1	1

Exercise :-

$$f_1 = x_1 \bar{x}_2 + x_2 \bar{x}_3 + x_3 \bar{x}_1$$

$$f_2 = x_1 x_2 + \bar{x}_3$$

$$f_3 = x_3 + x_3 x_2 + (x_1 + x_2) x_3$$

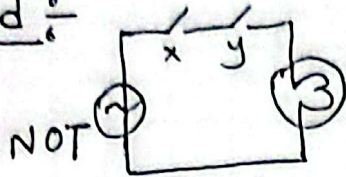
⊕ Truth table draw করতে 1st

দেখবো Input কয়টি then

draw কয়টি

④ Logic Gate :-

And :-



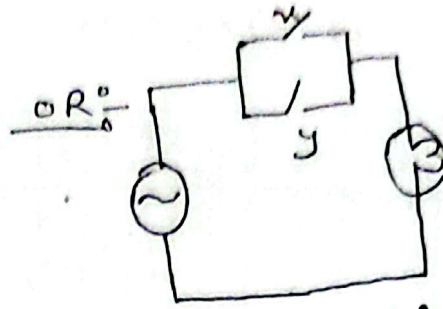
logic 0 $\rightarrow$ 0V

logic 1 $\rightarrow$ +5V

Truth table :-

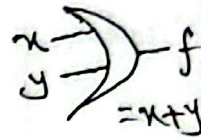
x	y	f
0	0	0
0	1	0
1	0	0
1	1	1

x y $\rightarrow$ $f = xy$
 symbol



Truth table :-

x	y	x+y
0	0	0
0	1	1
1	0	1
1	1	1



Question type :-

Problem $\rightarrow$ truth table $\rightarrow$ f^m expression

implements function.

Function to truth table :-

$$f_1 = \bar{x}_1 + x_1 x_2$$

$$f_2 = \bar{x}_1 + x_2$$

x_1	x_2	$\bar{x}_1$	$x_1 x_2$	f_1	f_2
0	0	1	0	1	1
0	1	1	0	1	1
1	0	0	0	0	0
1	1	0	1	1	1

Exercise :-

$$f_1 = x_1 \bar{x}_2 + x_2 \bar{x}_3 + x_3 \bar{x}_1$$

$$f_2 = x_1 x_2 + \bar{x}_3$$

$$f_3 = x_3 + x_3 x_2 + (x_1 + x_2) x_3$$

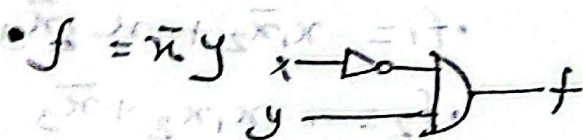
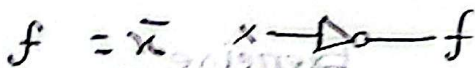
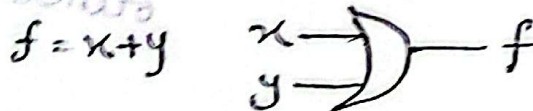
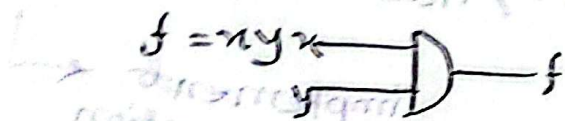
④ Truth table draw করতে 1st দেখাও- input কম্বো then draw করতে

Q. $f = (\bar{x}_1 + x_2)x_3 + \bar{x}_2$ Draw the truth table?

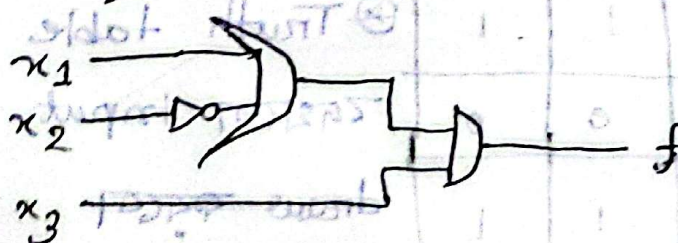
Soln

x_1	x_2	x_3	$\bar{x}_1$	$\bar{x}_2$	$\bar{x}_1 + x_2$	$(\bar{x}_1 + x_2)x_3$	f
0	0	0	1	1	1	0	1
0	0	1	1	1	1	1	1
0	1	0	1	0	1	0	0
0	1	1	1	0	1	1	1
1	0	0	0	1	0	0	1
1	0	1	0	1	0	0	1
1	1	0	0	0	1	0	0
1	1	1	0	0	1	1	1

Q. Draw logic diagram :-



$f = (x_1 + \bar{x}_2)x_3$

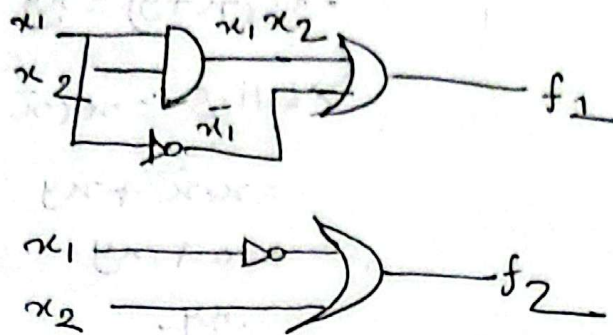


x_1	x_2	$\bar{x}_2$	$x_1 + \bar{x}_2$	x_3	f
0	0	1	1	0	0
0	1	0	1	0	0
1	0	1	1	0	0
1	1	0	1	1	1

$$\textcircled{\#} f_1 = \bar{x}_1 + x_1 x_2$$

$$f_2 = \bar{x}_1 + x_2$$

x_1	x_2	f_1	f_2
0	0	1	1
0	1	1	1
1	0	0	0
1	1	1	1



২য় function এর output same
 but f_2 এর মধ্যে gate কম
 লাগে so f_2 cost efficiency.

For f_2 function:-

OR-1	OR-1
AND-1	NOT-1
NOT-1	2
3	

Trick:- একটি function equation মত simple হবে তাকে implement করতে cost উত্তর কম হবে।

cost minimize $\propto$ function simplification.

How to simplify function

2 ways $\rightarrow$ Boolean Algebra
 $\rightarrow$ K-map

Basic Boolean Algebra

$$\bullet x + 1 = 1$$

$$\bullet x + 0 = x$$

$$\bullet x \cdot 1 = x$$

$$\bullet x \cdot 0 = 0$$

$$\bullet x \cdot x = x$$

$$\bullet x + x = x$$

$$\bullet x + \bar{x} = 1$$

$$\bullet \bar{\bar{x}} = x$$

$$\bullet x \cdot \bar{x} = 0$$

Lecture-04

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

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

$$\rightarrow \text{L.H.S} = x(\bar{x} + y)$$

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

$$= 0 + xy$$

$$= xy$$

De-morgan's

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

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

• Simplify the following f^n using Boolean Algebra/
Algebraic manipulation

$$\textcircled{1} f = x_1 \bar{x}_3 + \bar{x}_2 \bar{x}_3 + x_1 x_3 + \bar{x}_2 x_3$$

$$= x_1 \bar{x}_3 + x_1 x_3 + \bar{x}_2 \bar{x}_3 + \bar{x}_2 x_3 \quad [x+y=y+x]$$

$$= x_1 (\bar{x}_3 + x_3) + \bar{x}_2 (\bar{x}_3 + x_3) \quad [x(y+z) = xy + xz]$$

$$= x_1 \cdot 1 + \bar{x}_2 \cdot 1 \quad [x + \bar{x} = 1]$$

$$= x_1 + \bar{x}_2 \quad [x \cdot 1 = x]$$

$$\textcircled{2} f = \bar{x}_1 \bar{x}_2 + x_1 x_2 + x_1 \bar{x}_2$$

$$= \bar{x}_1 \bar{x}_2 + x_1 (x_2 + \bar{x}_2) \quad [x(y+z) = xy + xz]$$

$$= \bar{x}_1 \bar{x}_2 + x_1 \cdot 1 \quad [x + \bar{x} = 1]$$

$$= \bar{x}_1 \cdot \bar{x}_2 + x_1 \quad [x \cdot 1 = x]$$

$$= x_1 + \bar{x}_2 \quad [x + \bar{x}y = x + y]$$

$$\begin{bmatrix} x = x_1 \\ y = \bar{x}_2 \end{bmatrix}$$

Q Prove that,
 $(\bar{x}+y)^2 + xy = \bar{y}(x+2)$

Soln. L.H.S = $(\bar{x}+y)^2 + xy$
 $= \bar{x}\bar{y}^2 + xy \quad [\bar{x}+y = \bar{x} \cdot \bar{y}]$
 $= \bar{y}(\bar{x}^2 + x) \quad [xy + x^2 = x(y+2)]$
 $= \bar{y}(x+2) \quad [x + \bar{x}y = x+y]$
 $= R.H.S$

$\therefore L.H.S = R.H.S$ (proved)

Q Simplify this equation:

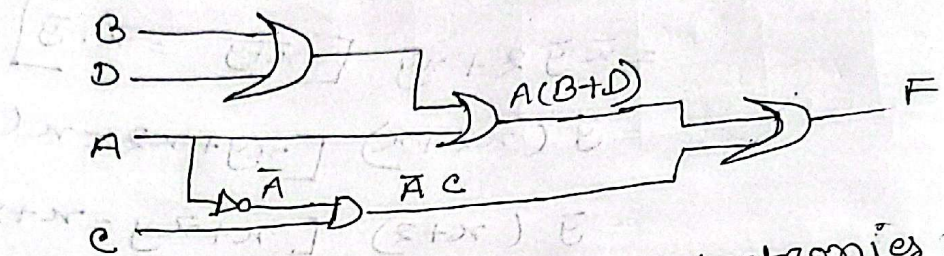
$$AB + \bar{A}CD + \bar{A}BD + \bar{A}C\bar{D} + ABC\bar{D}$$

Soln. $AB + \bar{A}CD + \bar{A}BD + \bar{A}C\bar{D} + ABC\bar{D}$
 $= AB + ABC\bar{D} + \bar{A}CD + \bar{A}C\bar{D} + \bar{A}BD \quad [A+B = 1]$
 $= AB(1 + \bar{C}\bar{D}) + \bar{A}C(D + \bar{D}) + \bar{A}BD$
 $= AB \cdot 1 + \bar{A}C \cdot 1 + \bar{A}BD \quad [x+1 = 1, x+\bar{x} = 1]$
 $= AB + \bar{A}C + \bar{A}BD \quad [x \cdot 1 = x]$
 $= AB + \bar{A}BD + \bar{A}C \quad [x+y = y+x]$
 $= B(A + \bar{A}D) + \bar{A}C \quad [x(y+z) = xy + xz]$
 $= B(A + D) + \bar{A}C \quad [x + \bar{x}y = x+y]$

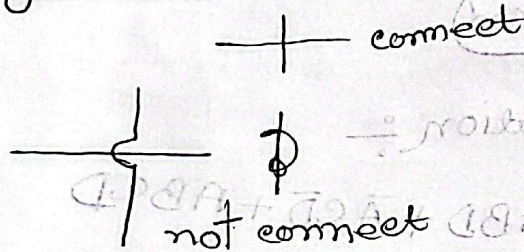
5 literals

Draw logic circuit :

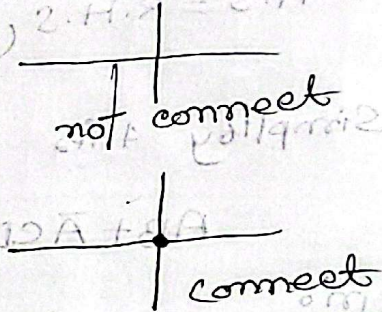
$$A(B+D) + \bar{A}C$$



Analog circuit :



Digital electronics :



Complement of a function :- complement of f means inverse.

⊙ $\bar{f}$ is complement function of f .

Ex :- ① $f = \overline{xy}$ find out complement function?

Solⁿ :- $\bar{f} = \overline{\overline{xy}} = xy$ [$\bar{\bar{x}} = x$]

② $f = \overline{x+y}$

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

Q 3. $f = \bar{x}y + xy$ find out $\bar{f} = ?$

Solⁿ $\bar{f} = \overline{\bar{x}y + xy}$
 $= \overline{\bar{x}y} \cdot \overline{xy}$ [De-morgan]
 $= (\bar{x} + \bar{y}) \cdot (\bar{x} + y)$ [De-morgan]
 $= (\bar{x} + y)(\bar{x} + \bar{y})$ [$\bar{\bar{x}} = x$]

Q 4. From this equation $f = x'y + (xy'z' + w')x$ find out complement function?

Solⁿ Given function,
 $f = x'y + (xy'z' + w')x$

$\therefore$ Complement function, $\bar{f}$

$= (x + y') (x' + y' + z) \cdot w + \bar{x}$ [By using De-morgan]

Lecture-05 :- Qn :- Consider the following f^n :

$f(x_1, x_2, x_3) = \sum m(1, 4, 5, 6)$

- Prepare the truth table?
- expression of f in SOP form?
- Obtain the optimized SOP form?
- Logic diagram?
- Cost calculation?

③ $f = \bar{x}y + x\bar{y}$ Now find out $\bar{f} = ?$

Soln:

$$\begin{aligned}\bar{f} &= \overline{\bar{x}y + x\bar{y}} \\ &= \overline{\bar{x}y} \cdot \overline{x\bar{y}} \quad [\text{De-morgan}] \\ &= (\bar{x} + \bar{y}) \cdot (x + y) \quad [\text{De-morgan}] \\ &= (x + \bar{y})(\bar{x} + y) \quad [\bar{x} = x]\end{aligned}$$

④ From this equation $f = x'y + (xyz' + w')x$ Find out complement function?

Soln: Given function,

$$f = x'y + (xyz' + w')x$$

$\therefore$ Complement function, $\bar{f}$

$$= (x + y') (x' + y' + z) \cdot w + \bar{x} \quad [\text{By using De-morgan}]$$

Lecture-05: Qn: Consider the following f^m :

$$f(x_1, x_2, x_3) = \sum m(1, 4, 5, 6)$$

- Prepare the truth table?
- expression of f in SOP form?
- Obtain the optimized SOP form?
- Logic diagram?
- Cost calculation?

Date: / /

SOP =

① Given function,

$$f(x_1, x_2, x_3) = \sum m(1, 4, 5, 6)$$

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

m means minterm

Dec. value

	x_1	x_2	x_3	f
0	0	0	0	0
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	0	1
5	1	0	1	1
6	1	1	0	1
7	1	1	1	0

② SOP = Sum of Products

$$f = m_1 + m_4 + m_5 + m_6$$

$$m_1 = \bar{x}_1 \bar{x}_2 x_3$$

$$m_4 = x_1 \bar{x}_2 \bar{x}_3$$

$$m_5 = x_1 \bar{x}_2 x_3$$

$$m_6 = x_1 x_2 \bar{x}_3$$

[from truth table (a)]

$$\therefore f = \bar{x}_1 \bar{x}_2 x_3 + x_1 \bar{x}_2 \bar{x}_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 \bar{x}_3$$

⊗ sum of product (বা অনুরূপ সমষ্টি) মিন্টার্ম ও বলা হয়।

ⓐ optimized / simplifies / Reduced form:

From b no,

$$f = \bar{x}_1 \bar{x}_2 x_3 + x_1 \bar{x}_2 \bar{x}_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 \bar{x}_3$$

$$= \bar{x}_1 \bar{x}_2 x_3 + x_1 \bar{x}_2 \bar{x}_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 \bar{x}_3$$

$$[x+y=y+x]$$

$$= \bar{x}_2 x_3 (\bar{x}_1 + x_1) + x_1 \bar{x}_3 (\bar{x}_2 + x_2)$$

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

$$= \bar{x}_2 x_3 + x_1 \bar{x}_3$$

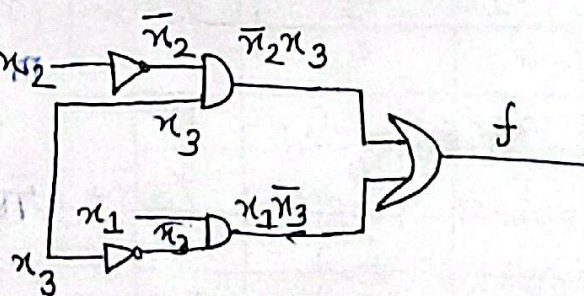
$$[x+\bar{x}=1]$$

$$(\text{Ans}) [x \cdot 1 = x]$$

ⓓ From c (we get,) $MST =$ (এখানে মিন্টার্ম)

$$f = \bar{x}_2 x_3 + x_1 \bar{x}_3$$

Logic Diagram / $\underline{M}$



ⓔ Cost = Number of gates + Number of inputs

For And gate = 2 + 4 = 6

For OR gate = 1 + 2 = 3

For NOT gate = 2 + 2 = 4

Total cost = 13

Qn: $f(x, y, z) = \sum m(2, 3, 4, 6, 7)$

(a) f in SOP form [Truth table not mandatory]

How to form SOP form without using truth table.

$$f = m_2 + m_3 + m_4 + m_6 + m_7$$

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

2 (010)
3 (011)
4 (100)
6 (110)
7 (111)

H.W: (b) reduce calculate?

(c) logic diagram?

(d) Cost calculation?

Qn: $f(x_1, x_2, x_3) = \prod M(0, 2, 3, 7)$

(a) f in POS form:

Product of Sum $\rightarrow$ POS

M = Maxterm $\rightarrow$ output function = 0

m = Minterm $\rightarrow$ output function = 1

$\prod$ = multiplication sign

$\sum$ = summation sign

x_1	x_2	x_3	f
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	0

$$\begin{aligned} \therefore f_{pos} &= M_0 \cdot M_2 \cdot M_3 \cdot M_7 \quad [0, 2, 3, 7 \text{ position 1 output zero रख}] \\ &= (\bar{x}_1 + \bar{x}_2 + \bar{x}_3) (\bar{x}_1 + \bar{x}_2 + x_3) (\bar{x}_1 + x_2 + \bar{x}_3) (\bar{x}_1 + x_2 + x_3) \end{aligned}$$

$$\therefore f_{sop} = \bar{x}_1 \bar{x}_2 x_3 + \bar{x}_1 \bar{x}_2 \bar{x}_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 \bar{x}_3$$

minterm means product is individually all elements to be 1.
maxterm means multiplication is individually all elements to be 0.

⑥ Simplifies product of sum function :-

$$\begin{aligned} f_{pos} &= (\bar{x}_1 + \bar{x}_2 + \bar{x}_3) (\bar{x}_1 + \bar{x}_2 + x_3) (\bar{x}_1 + x_2 + \bar{x}_3) \\ &= (a + \bar{x}_2) (a + \bar{x}_2) (b + x_1) (b + \bar{x}_1) \end{aligned}$$

product of sum function
যদি $(x+y)(y+z) =$
যদি $x+y$
যদি formula use
করতে হবে

$$\left[\text{let, } \bar{x}_1 + \bar{x}_3 = a; \bar{x}_2 + \bar{x}_3 = b \right]$$

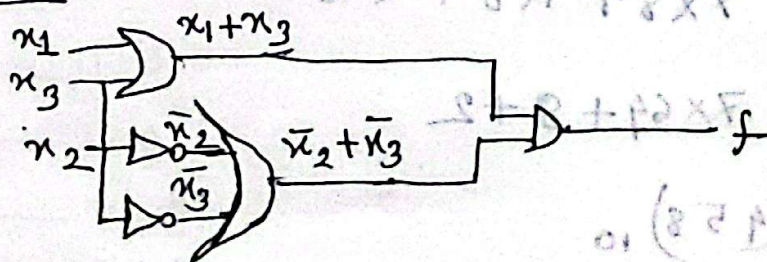
$$\begin{aligned} &= (a + \bar{x}_2 \bar{x}_2) (b + x_1 \bar{x}_1) \quad [(x+y)(y+z) = x + yz] \\ &= (a + 0) (b + 0) \quad [x \cdot \bar{x} = 0] \end{aligned}$$

$$= ab$$

$$= (\bar{x}_1 + \bar{x}_3) (\bar{x}_2 + \bar{x}_3)$$

[যদি $\bar{x}_1 + \bar{x}_3$ Same literal
থাকলে reduce করা যায়
but different literal থাকলে
(Ans) $\bar{x}_1 + \bar{x}_3$ reduce করা যায় না]

⑦ Logic Diagram :-



First Lecture (Redwan Sin)

⊕ Binary → Decimal

 $(11010)_2$

4	3	2	1	0

 position

$$1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$$

$$= (26)_{10}$$

Decimal → Decimal

 $(79)_{10}$

20 position

$$7 \times 10^1 + 9 \times 10^0$$

$$= 70 + 9 = 79$$

⊕ $(1101011)_2 = (?)_{10}$

$$1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$

$$= 64 + 32 + 0 + 8 + 0 + 2 + 1$$

$$= (107)_{10}$$

(Ans)

⊕ $(712)_8 = (?)_{10}$

$$\Rightarrow 7 \times 8^2 + 1 \times 8^1 + 2 \times 8^0$$

$$= 7 \times 64 + 8 + 2$$

$$= (458)_{10}$$

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

$$1 \text{ bit} \rightarrow 2^1$$

$$2 \text{ bit} \rightarrow 2^2$$

$$3 \text{ bit} \rightarrow 2^3$$

$$n \text{ bit} \rightarrow 2^n$$

⊗ যদি যেসমি bit নিউ হয় তবে
co-responding উদাহরণ value নিউ
হবে

Hexa — Binary

0 — 0000

1 — 0001

2 — 0010

3 — 0011

4 — 0100

5 — 0101

6 — 0110

7 — 0111

8 — 1000

9 — 1001

10 — 1010

11 — 1011

12 — 1100

13 — 1101

14 — 1110

15 — 1111

$$\textcircled{*} (1A)_{16} = (?)_{10}$$

$$= 1 \times 16^1 + 10 \times 16^0$$

$$= 26$$

Radix point

$$\textcircled{*} (101.110)_2 = (?)_{10}$$

$$= 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2}$$

$$= 5 + \frac{1}{2} + \frac{1}{4}$$

$$= (5.75)_{10} \text{ (Ans.)}$$

$$(1A2.3F)_{16} = (?)_{10}$$

$$= 1 \times 16^2 + 10 \times 16^1 + 2 \times 16^0 + 3 \times 16^{-1} + 15 \times 16^{-2}$$

$$= 256 + 160 + 2 + 0.1875 + 0.0585$$

$$= 418.246 \quad (\text{Ans.})$$

⊕ Decimal to Binary

$$(123)_{10} = (?)_2$$

$$\begin{array}{r} 2 \overline{) 123} \\ \underline{2 61} 1 \\ 2 \overline{) 61} 1 \\ \underline{2 30} 1 \\ 2 \overline{) 30} 1 \\ \underline{2 15} 0 \\ 2 \overline{) 15} 0 \\ \underline{2 7} 1 \\ 2 \overline{) 7} 1 \\ \underline{2 3} 1 \\ 2 \overline{) 3} 1 \\ \underline{2 1} 1 \\ 0 1 \end{array}$$

MSB (Most significant Bit)

LSB (Least significant Bit)

(1111011)₂

(MSB)

* $(555)_{10} = (?)_2$

$$\begin{array}{r}
 2 \overline{) 555} \\
 \underline{277} \quad -1 \\
 2 \overline{) 138} \\
 \underline{69} \quad -0 \\
 2 \overline{) 34} \\
 \underline{17} \quad -0 \\
 2 \overline{) 8} \\
 \underline{4} \quad -0 \\
 2 \overline{) 2} \\
 \underline{1} \quad -0 \\
 0 \quad -1
 \end{array}$$

LSB

MSB

$(1000101011)_2$

$(.133)_{10} = (?)_2$

$$\begin{array}{l}
 .133 \times 2 = 0.266 \\
 .266 \times 2 = 0.532 \\
 .532 \times 2 = 1.064 \\
 .064 \times 2 = 0.128
 \end{array}$$

$(.0010)_2$

Abin Sin

৯১. K-map (Karnaugh-map) :- • directly optimized form নামে K-map প্রকাশ পাওয়া যায়।

- 1st of all ক্রিয়াজনক হয়ে বাক্য বিধে input.

Qn. $f = \sum m(1, 4, 5, 6)$ ^{miniterm} Draw k-map?

Soln.

input $\rightarrow$ 3 bit (x_1, x_2, x_3)

K-map = Truth table

$x_1 x_2$
 x_3

	00	01	11	10
0	0	0	1	1
1	1	0	0	1

K-Map
 4's
 K-
 d.b.

* K-map At a time একটি bit
এর মান change হবে।

K-map truth table एउटा एउटा
different form .

Qn-a obtain the optimized sop form using k-map,

Sum-of-Product / Sum-of-minterms.

For Grouping:

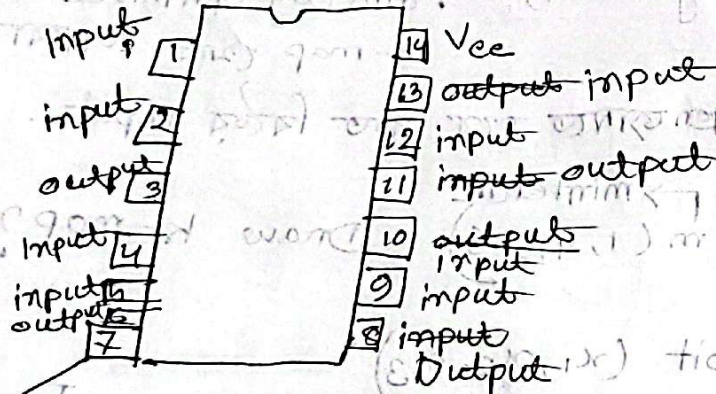
2, 4, 8, 16 → অর্থাৎ doubling এর ক্ষেত্রে
10 গুলো order অনুযায়ী
একসাথে থাকবে।

$$f = x_1 \bar{x}_3 + \bar{x}_2 x_3 \quad (1, 5 \text{ numbering column})$$

(6, 4) Numbering column (4th row)

DLD Lab

Volt meter
 4 black wire
 ground 4
 Red wire for
 check 7.5V



4th and gate
 created.

	00	01	10	11
00	0	0	0	0
01	0	1	0	0
10	0	0	0	1
11	1	0	0	0

0-0

10100000

0.00000000

Qⁿ: $f(x_1, x_2, x_3) = \sum m(0, 2, 4, 5, 6)$; Draw K-map and create SOP form?

Solⁿ: Given function,

$$f(x_1, x_2, x_3) = \sum m(0, 2, 4, 5, 6)$$

K-map given below:

$x_1 x_2$	00	01	11	10
x_3	0	2	6	4
0	1	1	1	1
1	0	0	0	1

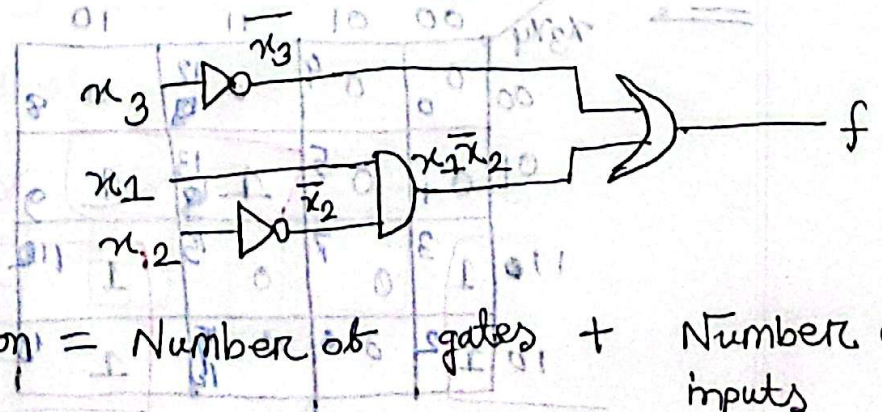
⊗ K-map থেকে SOP form create করার নিয়ম:

১) মেই গ্রুপগুলোতে 1 আছে এগুলোতে x_1, x_2, x_3 এর Binary value compare করো যদি same টির value 2- same থাকে তবে এটির equation create করো নমুনা ওটা বাদ দিও

$$f = \bar{x}_3 + x_1 \bar{x}_2$$

⊗ SOP → target 1.

logic Diagram:



⊗ Cost calculation = Number of gates + Number of inputs

For AND Gate = $1+2=3 = (x^1, x^2, x^3)$

For OR Gate = $1+2=3$

For Not Gate = $2+2=4$

Total cost = 10 (Ans)

Qn: $f = \sum m(0, 2, 4, 5, 6, 7)$ Draw K-map and

find out optimized form?

Soln:

$x_1 x_2$	00	01	11	10
0	1 ₀	1 ₂	1 ₆	1 ₄
1	0	0	1 ₇	1 ₅

∴ optimized form = $\bar{x}_3 + x$

Qn: $f = \sum m(2, 3, 9, 10, 11, 13)$ Draw K-map and

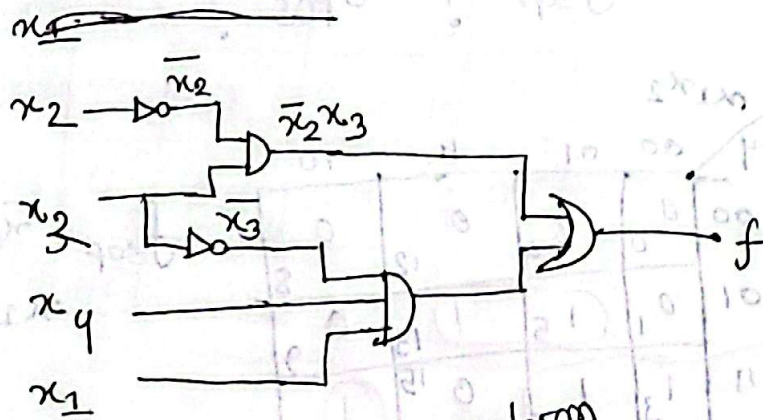
find out optimized form?

Soln:

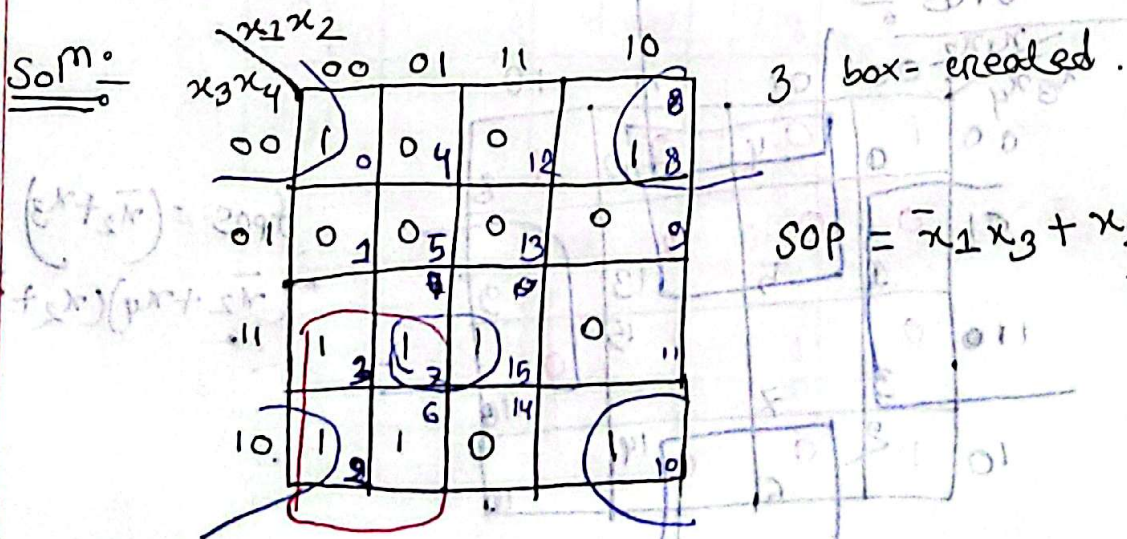
$x_1 x_2$	00	01	11	10
00	0	0	0	0
01	0	0	1	1
11	1	0	0	1
10	1	0	0	1

$f = \bar{x}_2 x_3 + x_1 \bar{x}_3 x_4$

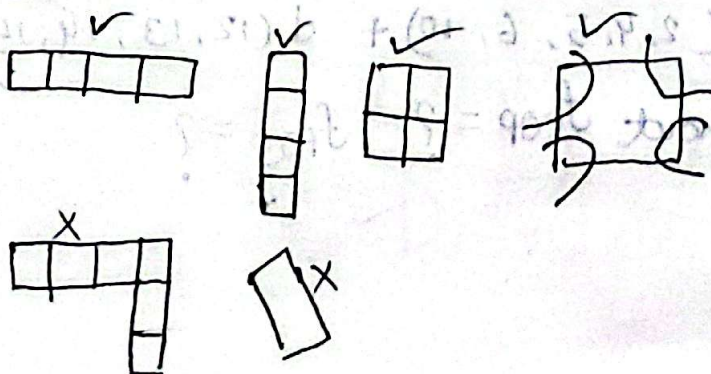
Logic diagram:-



Lecture-08:- Qn:- $f = \sum m(0, 2, 3, 6, 7, 8, 10, 15)$ Draw K-map and find out optimized form?



SOP form shadow:-



Maxterm $\rightarrow$ outputs $\rightarrow 0$

Qⁿ: $f = \prod M(0, 1, 4, 8, 9, 12, 15)$ Draw K-map and find out $f_{sop} = ?$ $f_{pos} = ?$

Solⁿ:

$x_3 x_4$	$x_1 x_2$ 00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	1	1	0	1
10	1	1	1	1

$$f_{sop} = \bar{x}_1 x_3 + x_3 \bar{x}_4 + x_1 \bar{x}_2 x_3 + x_2 \bar{x}_3 x_4$$

For f_{pos} :

$x_3 x_4$	$x_1 x_2$ 00	01	11	10
00	1	0	0	1
01	0	0	0	0
11	0	1	1	0
10	1	0	0	1

$$f_{pos} = (\bar{x}_2 + x_3)(\bar{x}_2 + x_4)$$

minterm $\rightarrow 1$ $\rightarrow$ don't care (0 or 1)

Qⁿ: $f = \sum m(2, 4, 5, 6, 10) + d(12, 13, 14, 15)$ By using K-map find out $f_{sop} = ?$ $f_{pos} = ?$

$SOP \Rightarrow$

$x_3x_4 \backslash x_1x_2$	00	01	11	10
00	0	0	1	0
01	0	1	1	0
11	0	0	d	0
10	1	1	d	1

$$f_{SOP} = x_2\bar{x}_3 + x_3\bar{x}_4$$

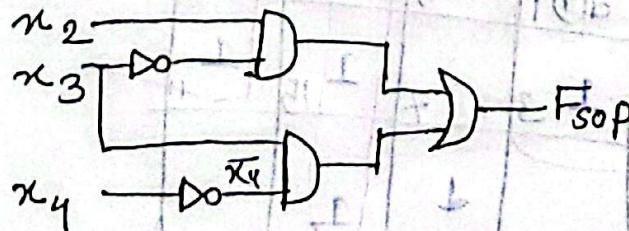
For f_{POS} term:

$x_3x_4 \backslash x_1x_2$	00	01	11	10
00	0	0	d	0
01	0	1	d	0
11	0	0	d	0
10	0	0	d	0

$$f_{POS} = (\bar{x}_3 + \bar{x}_4)(x_2 + x_3)$$

⑦ Logic Circuit:

$$f_{SOP} = x_2\bar{x}_3 + x_3\bar{x}_4$$



Cost calculation :-

$$\text{NOT} \rightarrow 2 + 2 = 4$$

$$\text{AND} \rightarrow 2 + 4 = 6$$

$$\text{OR} \rightarrow 1 + 2 = 3$$

13

Same as for f_{pos} .

Q^{no} $f = \sum m(3, 9, 11, 12, 13, 14, 15) + d(1, 4, 6)$

find out f_{sop} & f_{pos} term?

Sol^{no}

$x_1 x_2$

$x_3 x_4$

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

$x_3 x_4$

$x_1 x_2$

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

$f_{\text{sop}} = x_1 x_2 + \bar{x}_2 x_4$

$f_{\text{sop}} = x_1 x_2 + \bar{x}_2 x_4$

For POS :

x_1x_2	00	01	11	10
x_3x_4	00 0	01 4	11 2	10 12
01	0	1	1	1
11	1	3	7	1
10	2	6	1	11

$f_{pos} =$

x_1x_2	00	01	11	10
x_3x_4	00 0	01 d	11 0	10 0
01	d	0		
11		0		
10	0	d		0

$$f_{pos} = (\bar{x}_1 + \bar{x}_2)(x_2 + x_4)$$

logic circuit :

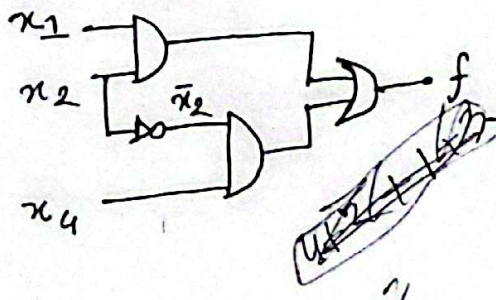
$$f_{sop} = x_1x_2 + \bar{x}_2x_4$$

Cost :

AND - $2 + 4 = 6$

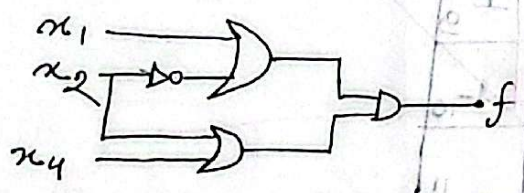
OR - $2 + 2 = 4$

NOT - $1 + 1 = 2$



bon f_{POS}

$$f_{POS} = (x_1 + \bar{x}_2)(x_2 + x_4)$$



Cost %
AND $\rightarrow 1+2=3$
NOT $\rightarrow 1+1=2$
OR $\rightarrow 2+2=4$

Total Cost % 11

	01	11	10	00
01	1	1		
11		1		
10			1	
00				1

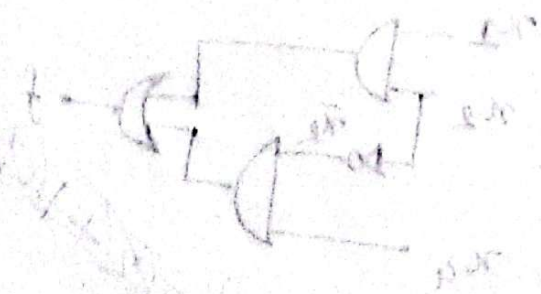
$$(x_1 + \bar{x}_2)(x_2 + x_4) = 2096$$

	01	11	10	00
01	0		0	0
11		0	0	0
10			0	0
00				0

Cost %

$$x_1 \bar{x}_2 + x_2 x_4 = 2096$$

AND $\rightarrow 3+1=4$
OR $\rightarrow 2+2=4$
NOT $\rightarrow 1+1=2$



⊛ $(56.27)_{10} = (?)_2$

Solⁿ:

$$\begin{array}{r}
 2 \overline{) 56} \\
 \underline{28} \\
 2 \overline{) 28} \\
 \underline{14} \\
 2 \overline{) 14} \\
 \underline{7} \\
 2 \overline{) 7} \\
 \underline{3} \\
 2 \overline{) 3} \\
 \underline{1} \\
 2 \overline{) 1} \\
 \underline{0}
 \end{array}$$

0 → 1

$$\begin{array}{r}
 .27 \\
 \times 2 \\
 \hline
 0 54 \\
 \times 2 \\
 \hline
 1 08 \\
 \times 2 \\
 \hline
 0 16 \\
 \times 2 \\
 \hline
 0 32
 \end{array}$$

$(56.27)_{10} = (111000.0100)_2$

(Ans.)

Binary to Octal:

⊛ $(001101011010)_2 = (1532)_8$

⊛ $(001110011.101100)_2 = (?)_8 = (163.54)_8$

⊛ $(001011.111100)_2 = (13.74)_8$

(15)

Binary to Hexa:

$$\begin{array}{|c|c|c|c|} \hline 0011 & 0101 & 1010 & 1011 \\ \hline 3 & 5 & A & B \\ \hline \end{array} = (35AB)_{16}$$

$$\begin{array}{|c|c|c|c|} \hline 0001 & 0101 & 1000 & 1000 \\ \hline 1 & B & D & 8 \\ \hline \end{array}$$

$$= (1B.D8)_{16} = (858.68)_{10}$$

$$\oplus (110101.111)_2$$

① Octal = ? ② Hexa = ? ③ Decimal = ?

$$\textcircled{i} \begin{array}{|c|c|c|c|} \hline 1101 & 001 & 111 & \\ \hline 6 & 5 & 7 & \\ \hline \end{array} = (65.7)_8$$

②

$$\begin{array}{|c|c|c|c|} \hline 0011 & 0101 & 1110 & \\ \hline 3 & 5 & E & \\ \hline \end{array} = (35.E)_{16}$$

$$\textcircled{iii} 3 \times 16^1 + 5 \times 16^0 + 14 \times 16^{-1} = 48 + 5 + 0.875 = (53.875)_{10}$$

$$8(1532) = (1101011010)_2 \quad \text{(Ans)}$$

Octal to Binary:

$$(1532)_8 = (1101011010)_2$$

$\begin{array}{c} 001 \\ 101 \\ 011 \\ 010 \end{array}$

⊕ Hexa to Binary :-

8 4 2 1

$$(1B.D8)_{16} = (11011.11011000)_2$$

1B → 0001 1011
 D8 → 1101 1000

$$(237.76)_8 = (10011111.111110)_2$$

2 → 010
 3 → 011
 7 → 111
 7 → 111
 6 → 110

⊕ Octal to Hexa :-

$$(237.76)_8 = (9F.F8)_{16}$$

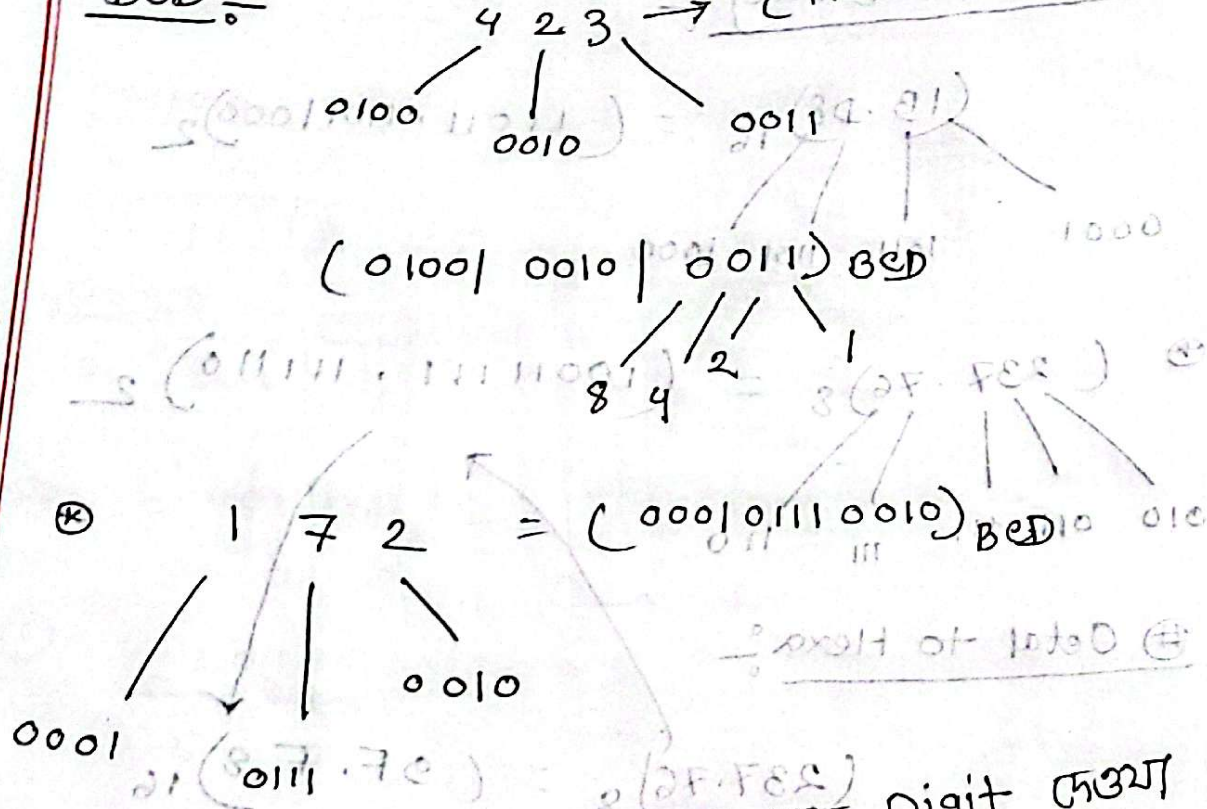
$$(222.55)_8 = (92.B4)_{16}$$

222 → 010 010 010 → 9
 55 → 101 100 → B 4

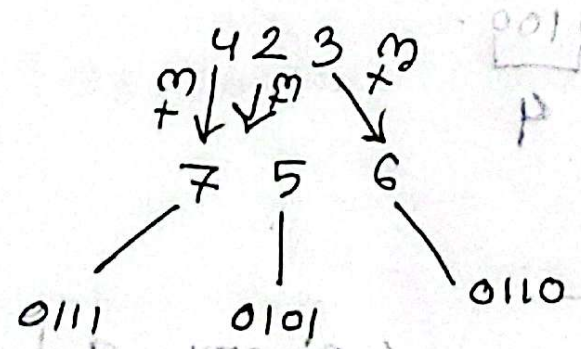
⊕ Binary Coding :-

- ① BCD / 8421 (Binary Coded Decimal)
- ② Excess-3 / XS-3
- ③ 84-2-1
- ④ Gray

BCD ÷

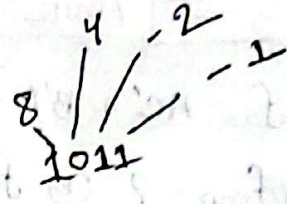


Excers - 3 ÷ 3-এর জায়গায় যে Digit দেওয়া থাকবে Dec এর সাথে ৩ত মোগ করবে।
~~Dec + 3 → BCD~~
 Dec + 3 → BCD



$(423)_{10} = (0111 \ 0101 \ 0110)_{BCD}$ Excers-3

$8 - 2 - 1 = 5$

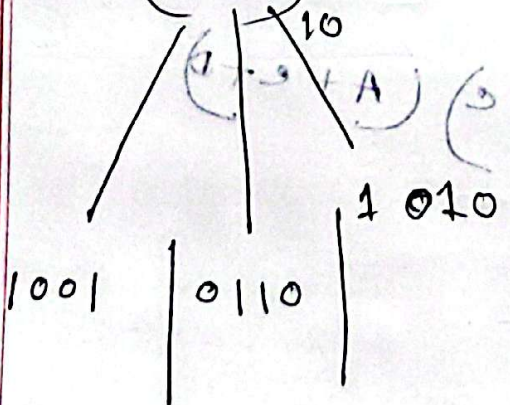


$8 - 2 - 1 \quad 4 + (-1) \quad 8 + (-2) + (-1)$

$0 = 0, 1 = 1 \Rightarrow A = 3$
 $1 = 0, 0 = 0 \Rightarrow A = 5$
 $0 = 1, 1 = 0 \Rightarrow A = 5$
 $1 = 1, 0 = 0 \Rightarrow A = 5$
 $(5, 3, 5)_{10}$

01	11	10	00
11	11	01	00
11	11	01	10
11	11	01	11
00	00	00	01

$(7, 2, 6)_{10} =$

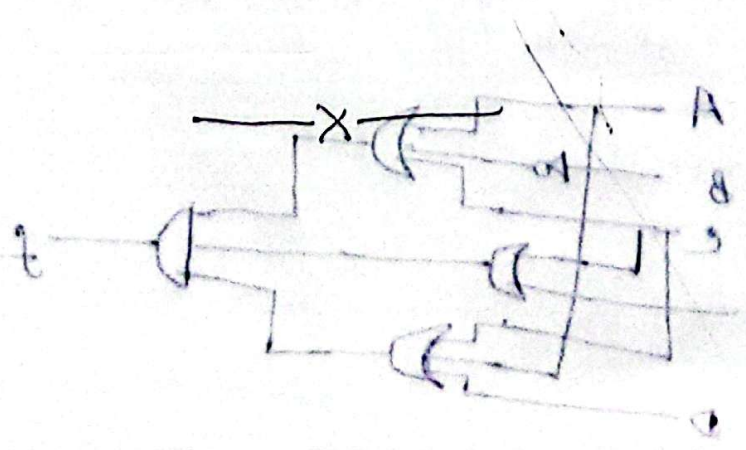


$8, 4, 2, 1$

Gray

- 0 - 0000
- 1 - 0001
- 2 - 0010
- 3 - 0011

Just 1 bit change



Lecture - 09 Abir Sin

[minterm form]

$$Q^{no} \quad f = AC' + B'D + A'CD + ABCD$$

(a) $f_{sop} = ?$ (b) $f_{pos} = ?$ (c) cost calculation? (d) logic diagram

Sol^{no}:

AB \ CD	00	01	11	10
00	0	0	1	1
01	1	0	1	1
11	1	1	1	1
10	0	0	0	0

$$A'C; A=1, C=0$$

$$B'D; B=0, D=1$$

$$A'CD; A=0, C=1, D=1$$

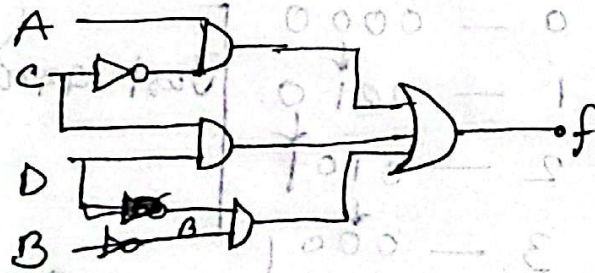
$$ABCD; A=1, B=1, C=1, D=1$$

$$a) f_{sop} = A\bar{C} + \bar{C}D + \bar{B}D$$

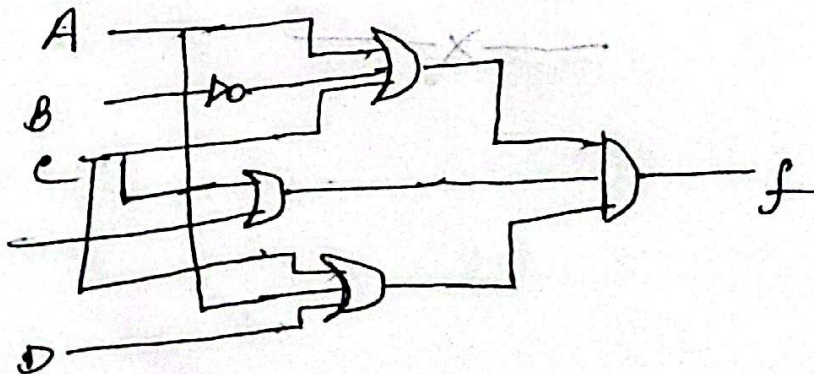
$$b) f_{pos} = (\bar{C} + D)(A + \bar{B} + C)$$

(c) Logic circuit:-

$f_{sop}:-$



$f_{pos}:-$



Q^{no} $F(A, B, C, D) = (A' + B' + D')(A + B' + C')(A' + B + D')(B + C' + D')$

① $f_{sop} = ?$ ② $f_{pos} = ?$

Sol^{no}

CD \ AB	00	01	11	10
00	1	1	0	1
01	1	1	0	0
11	0	0	0	0
10	1	0	1	1

$A' + B' + D' \equiv A=1, B=1, D=1$

$A + B' + C' \equiv A=0, B=1, C=1$

$A' + B + D' \equiv A=1, B=0, D=1$

$B + C' + D' \equiv B=0, C=1, D=1$

① $f_{sop} = \bar{A}\bar{C} + \bar{C}\bar{D} + A\bar{C}\bar{D} + B\bar{D}$

② $f_{pos} = (\bar{A} + \bar{D})(\bar{C} + \bar{D})(A + B + \bar{C})$

Q^{no} f-expression

- ① Canonical form / original (expression)
 ② Standard form / simplified / Reduced / optimised form
 Canonical form $\rightarrow$ SOP = Sum-of-minterms (SOM)
 POS = POM (product-of-Minterm)

Q^{no} Express the following function in sum-of-minterm:

$f(A, B, C) = AC' + BC + A'B'$

Sol^{no} sum of minterm means product of minterm. so all input have all term.

without using k-map

$f = AC' + BC + A'B'$

$= AC' \cdot 1 + BC \cdot 1 + A'B' \cdot 1$

$= AC'(B + \bar{B}) + BC(A + \bar{A}) + A'B'(\bar{C} + C) \quad [x + \bar{x} = 1]$

$$= ABC' + AB'C' + ABC + A'BC + A'B'C' + AB'C [x(y+z) = xy + xz]$$

⊗ If there have same two term we should use $[x+x=x]$

By using K-map:

	AB	00	01	11	10
C	0	1	0	1	1
1	1	1	1	0	

$$f_{sop} = A'B'C' + A'B'C + A'BC + ABC' + ABC + AB'C'$$

Qⁿ: Express the following function in sum-of-minterm

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

Solⁿ: By using Boolean function,

$$\begin{aligned} & x' + x(x+y)(y+z') \\ &= x' + x(xy + xz') \\ &= x' + (x + xy)(y+z') [x \cdot x = x] \end{aligned}$$

$$\begin{aligned} &= x' + xy + xz' + xy'y + xy'z' \\ &= x' + xy + xz' + xy'z' [yy' = 0] \end{aligned}$$

$$\begin{aligned} &= x'(x+y)(y+y') + xy(z+z') + xz'(y+y') + xy'z' \\ &= x'(xy + xy' + x'y + x'y') + xyz + xy'z' + xyz' + xy'z + xy'z' \end{aligned}$$

$$= x'zy +$$

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

$$= x'(yz+yz'+y'z+y'z') + xyz+xyz' + xyz' + xy'z' + xy'z'$$

$$= x'yz + x'yz' + x'y'z + x'y'z' + xyz + xyz' + xyz' + xy'z' [x+x=x]$$

$$= x'yz + x'yz' + x'y'z + x'y'z' + xyz + xyz' + xyz' + xy'z' \quad (\text{Ans})$$

⊕ Express the following function in

product-of-sum form:

$$\textcircled{1} \oplus f(A, B, C) = (AB+C)(B+A'B'C)$$

$$\textcircled{II} \oplus f(P, Q, R, S) = (P'+Q+R)(Q'+R+S')(P+Q'+R'+S)$$

Soln:

$$\textcircled{II} f = (P'+Q+R)(Q'+R+S')(P+Q'+R'+S) [x \cdot \bar{x} = 0]$$

$$= (P'+Q+R+0)(Q'+R+S'+0)(P+Q'+R'+S)$$

$$= (P'+Q+R+S \cdot S')(Q'+R+S'+P' \cdot P)(P+Q'+R'+S)$$

$$= (P'+Q+R+S)(P'+Q+R+S')(P+Q'+R'+S) [x+y \cdot \bar{x} = (x+y)(x+\bar{x})]$$

$$\textcircled{I} f(A, B, C) = (AB+C)(B+A'B'C)$$

$$= (A+C)(B+C)(B+A'B'C) [x + x'y = x+y]$$

$$= (A+C)(B+C)(A+B)(B+C) [x+y \cdot \bar{x} = (x+y)(x+\bar{x})]$$

$$= (A+C)(B+C)(A'+B) \quad [xx=x]$$

$$= (A+C+B \cdot B') (B+C+A \cdot A') (A'+B+C \cdot C') \quad [xx'=0]$$

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

$$[x+yz = (x+y)(x+z)]$$

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

SOM form to POS form convention:

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

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

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

⊕ Prime implicants (PI) + Essential prime implicants (EPI)

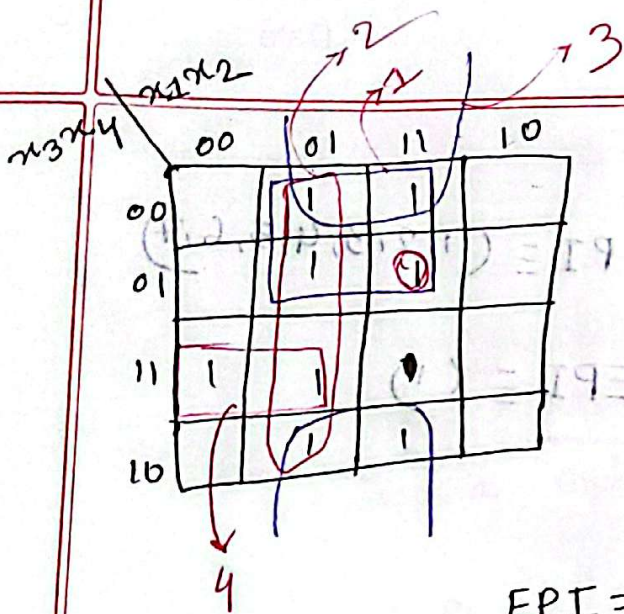
⊕ How to find out PI and EPI from k-map

PI = All possible group.

⊕ $f_{SOM} = \text{sum of minterms}$

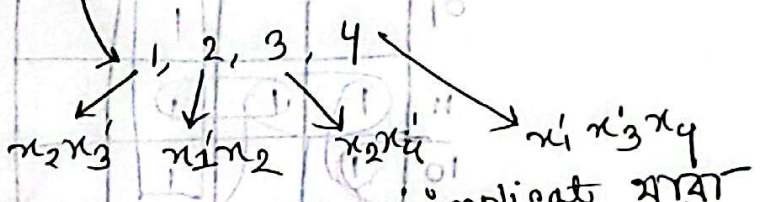
$$f = x_1 x_2 x_3 + x_1 x_2 x_3'$$

implicant = product



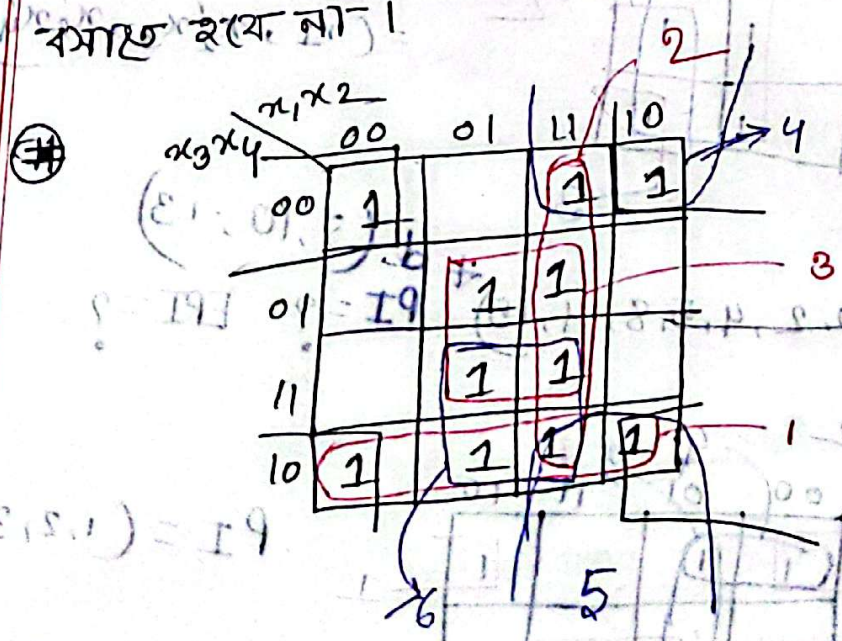
PI = all possible group

$$\begin{aligned} 4 &\rightarrow (1, 2, 3, 4) \\ 2 &\rightarrow (2, 3) \end{aligned}$$



EPI = সেই সকল prime implicant যারা অন্য কোনও গ্রুপের ওপর মাথ common করে।

prime implicant এ কয়টি 1 থাকলে হবে K-map এ 0-গুলি বসাতে হবে না।



$$\begin{aligned} PI &= (1, 2, 3, 4, 5, 6) \\ &= (x_3x_4, x_1x_2, x_2x_4, x_1x_3, x_2x_3) \end{aligned}$$

$$\begin{aligned} EPI &= (3, 4) \\ &= (x_2x_4, x_1x_3) \end{aligned}$$

9. #

$x_3 x_4 \backslash x_1 x_2$	00	01	11	10
00	1	1	1	
01			1	
11	1	1	1	
10	1			

$$PI = (1, 2, 3, 4, 5, 6, 7)$$

$$EPI = (1)$$

#

$x_3 x_4 \backslash x_1 x_2$	00	01	11	10
00	1		1	1
01			1	1
11	1		1	1
10	1		1	1

$$PI = (1, 2, 3)$$

$$= (x_1, x_2' x_3, x_2' x_4)$$

$$EPI = (1, 2, 3)$$

$$= (x_1, x_2' x_3, x_2' x_4)$$

Qm. $f = \sum m(0, 2, 4, 5, 8, 14, 15)$ $PI = ?$ $EPI = ?$

Som.

$x_3 x_4 \backslash x_1 x_2$	00	01	11	10
00	1	1		1
01		1	d	
11		d	d	
10	1		1	d

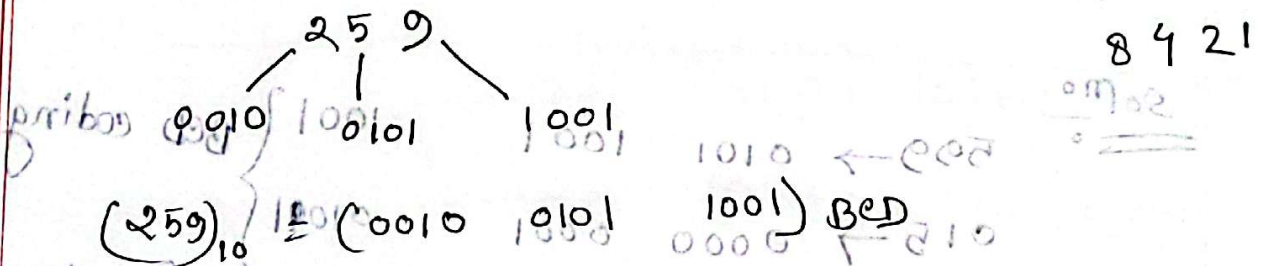
$$PI = (1, 2, 3, 4, 5, 6)$$

$$EPI = (1)$$

Don't care
এর জন্য EPI
হবে না।

Don't care free বাসমান EPI হলে না। অর্থাৎ 1 free বাসমান EPI হলে।

- ⊕ BCD :-**
- Binary Coded Decimal
 - 4bit representation (each digit)
 - It is a coding not conversion.



BCD Addition :- Method 1

- ① Find $(599)_{10} + (015)_{10}$
- ② 599, 015 using BCD addition
- ③ perform BCD Addition.

Valid BCD code, অর্থাৎ মান ০-৯ পর্যন্ত।

How to perform BCD addition :-

- ① corresponding BCD to convert করবে।
 - ② Binary addition perform করবে।
 - ③ validity check করবে। যদি ৯-এর বেশি হয় তবে ৬ (0110) যোগ করবে।
- এর মর্মে আছে কিনা?

- ④ যদি invalid হয় তবে invalid part টুকর
সাথে 6 এর binary term যোগ করবে।
- ⑤ Then (4-bit এর বাকি শে) carry টুকর পাঠাবে
stage এ pass করে add করে দিবে। ওক তে
নিম্নে আদ্যো।

Solⁿ

599 → 0101 1001 101001 } BCD coding
015 → 0000 0001 01001001 } (005)

0101 1010 1110 } addition
10 (inv) 14 (inv) } validity
0110 0110 ← Invalid + 6

0101 1000 10100 addition
0101 0000 01000 (carry)
+1 +1
0110 0001 0100 ← addition

4 ← BCD

Qⁿ Find $(587)_{BCD} + (378)_{BCD} = (?)_{BCD}$

Solⁿ

সমাধান

58 $\rightarrow$ 0101 1000 0111
 (1000 0011 0010 0111) = 1000

$\frac{1000}{8}$ $\frac{1111}{15}$ $\frac{1111}{15}$ [addition]
 [validity]

1000 0110 0110 (add 6 with invalid term)
 (1001 0100 0110) =

1000 1010 1010 [addition]

1000 0101 0101 [carry]

1001 0110 0101 [addition]
 61 5 [BCD]

(Ami)
 carry = 0
 carry = 1
 carry = 1
 carry = 1

Binary code
 10-10 $\rightarrow$ 1010 $\rightarrow$ 1010
 10-01 $\rightarrow$ 1001 $\rightarrow$ 1001
 01-10 $\rightarrow$ 0110 $\rightarrow$ 0110
 01-01 $\rightarrow$ 0101 $\rightarrow$ 0101
 10-00 $\rightarrow$ 1000 $\rightarrow$ 1000
 01-00 $\rightarrow$ 0100 $\rightarrow$ 0100
 00-10 $\rightarrow$ 0010 $\rightarrow$ 0010
 00-01 $\rightarrow$ 0001 $\rightarrow$ 0001

④ (421)

⑥ (629)

$$Z = \begin{pmatrix} 0110 & 0010 & 1001 \end{pmatrix} \text{ BCD}$$

$$\begin{array}{r} 0 \\ + 0 \\ \hline 0 \end{array}$$

$$\begin{array}{r} 0 \\ + \\ \hline 11 \end{array}$$

$$\begin{array}{r} + 0 \\ \hline 12 \end{array}$$

$$\frac{+1}{0000}$$

Carry = 1

$$z = 1$$

$x=0$

$$y = 0$$

$$\text{sum} = 1$$

$$\text{carry} = 0$$

!

$$\frac{+1}{\theta \rightarrow \text{sum}}$$

$$\text{carry} = 1$$

1

$$\begin{array}{r} +0 \\ \hline 0 \rightarrow \text{sum} \end{array}$$

carry = 1

$+/$

1 → su

carry = 1

$(0-9) \rightarrow use$

(10-15) $\rightarrow$ blank (0) $\rightarrow$ ~~Set~~ Decimal $\checkmark$ Number

কুলো exist না এই ৬-এর
Binary সমাজ ব্যবস্থা।

BCD Addition :-

$$(21)_{10} = 0111 \ 1000_2$$

$$(77)_{10} = 0111 \ 0101 \ 0100_2$$

$$1110001 = 2(1F)$$

$$1011001 = 2(55)$$

(+)

$$\begin{array}{r} 1110 \ 1000 \\ 0000 \ 1101 \ 0000 \end{array}$$

$$\begin{array}{r} 10100 \ 100010 \\ 10001 \ 0010 \end{array}$$

$$\begin{array}{r} 10100 \ 100010 \\ 10001 \ 0010 \end{array}$$

$$\begin{array}{r} 10001 \ 0010 \end{array}$$

$\therefore$ Ans: (0001 0100 1000) BCD

এর Decimal value
(০১০) এর মধ্যে
নাই ১০ + ৬
(Binary) করণ।

Binary addition :-

$$\begin{array}{r} 2 \overline{) 71} \\ 2 \overline{) 35} - 1 \\ 2 \overline{) 17} - 01 \\ 2 \overline{) 8} - 1 \\ 2 \overline{) 4} - 0 \\ 2 \overline{) 2} - 0 \\ 2 \overline{) 1} - 0 \\ 0 - 1 \end{array}$$

$$\begin{array}{r} 1110111 \\ (1000111)_2 \end{array}$$

$$\begin{array}{r} 2 \overline{) 77} \\ 2 \overline{) 38} - 1 \\ 2 \overline{) 19} - 0 \\ 2 \overline{) 9} - 1 \\ 2 \overline{) 4} - 1 \\ 2 \overline{) 2} - 0 \\ 2 \overline{) 1} - 0 \\ 0 \rightarrow 1 \end{array}$$

$$\begin{array}{r} 01(100) = (00110111)_2 \\ 01(101) = (00100101)_2 \\ \hline 01(101) = (00100101)_2 \end{array}$$

$$(71)_2 = 1000111$$

$$(77)_2 = 1001101$$

8421

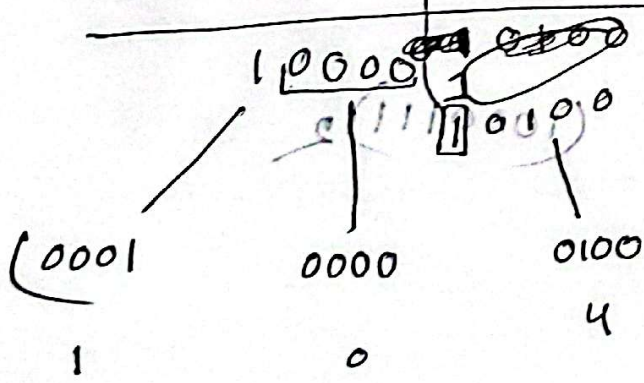
01 (1F)

add করার পর
1st দেখতে হবে (0-9)
exist করে কিনা?
~~then next~~

$$110 = 0001$$

$$448 = 0100010100$$

$$489 = 01001000$$



Summer-23°

$$(11101100)_2 = (236)_{10}$$

$$(10100100)_2 = (164)_{10}$$

Convert decimal°

$$(11101100)_2 = 1 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$= 128 + 64 + 32 + 0 + 8 + 4$$

$$= (236)_{10}$$

$$(10100100)_2 = 1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$= 128 + 0 + 32 + 0 + 0 + 4$$

$$= (164)_{10}$$

$$(236)_{10} = (00101100)_2$$

$$(164)_{10} = (00010100)_2$$

$$\begin{array}{r} 0100 \\ 1010 \\ \hline 110 \end{array}$$

$$\begin{array}{r} 0100 \\ 10000 \\ \hline 10000 \end{array}$$

$$\underline{\text{Ans}} := (0100 \ 0000 \ 0000)_{\text{BCD}}$$

$$\textcircled{1} \textcircled{A} (234)_x + (12)_x = (66)_x \quad ; \quad x = 2 \text{ or } 3$$

Bin $\rightarrow$ Decimal formula use করে করতে।

$$2 \times x^2 + 3 \times x^1 + 4 \times x^0 + 1 \times x^1 + 2 \times x^0 = 6 \times x^2 + 6 \times x^1$$

$$\Rightarrow 2x^2 + 3x + 4 + x + 2 = 6x^2 + 6x$$

$$\begin{array}{r} 2 \overline{) 30} \\ \underline{30} \\ 0 \end{array}$$

$$\Rightarrow 2R + 3R = 10R + 15$$

01 (282)

$$2r - 10r + 3r + 15 = 0$$

$$-8r + 15 = 0$$

$$-8r = -15$$

$$r = \frac{15}{8}$$

 $01 \text{ (par)} =$

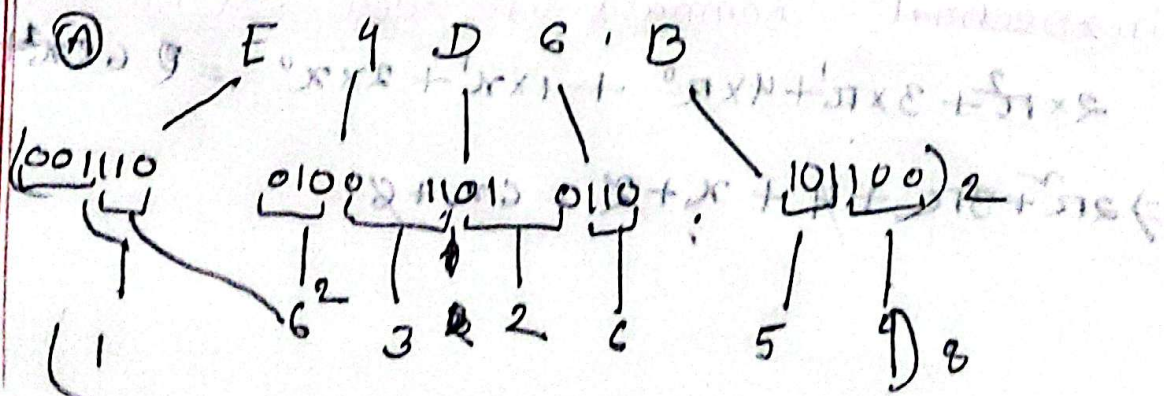
$$(405)_7 = (261)_{10}$$

$$\Rightarrow 4 \times r^2 - 60 \times r' + 5 \times r^0 = 261$$

$$\Rightarrow 472 + 5 = 261$$

$$= \gamma \pi = 64$$

$\therefore 172 = 8 \text{ (Ans.)}$

$$\kappa(\theta\theta) = \kappa(\theta 1) + \kappa(1\theta\theta) \quad (A) \quad (1)$$


② $(103)_4 = (0100\ 1000\ 1000)_2 = (0111101000)_2 = (23)_8$

Spring-23 :- @ Determine the radix r from the

following equation : $(405)_r = (261)_{10}$

Solⁿ $4 \times r^2 + 0 \times r^1 + 5 \times r^0 = 261$

$\Rightarrow 4r^2 + 5 = 261$

$\Rightarrow 4r^2 = 256$

$\Rightarrow r^2 = 64$

$\therefore r = 8$ (Ans)

⑥ Encode the following numbers $(157)_8$ and $(234)_8$ to BCD binary format and perform BCD addition?

Solⁿ

$(157)_8 = (111)_{10}$

$(234)_8 = (156)_{10}$

BCD addition given below :-

8 4 2 1

$(111)_{10} = (0001 \ 0001 \ 0001)_{BCD}$ (Ans.)

$(156)_{10} = (0001 \ 1010 \ 1100)_{BCD}$

$(0010 \ 0110 \ 0111)_{BCD}$

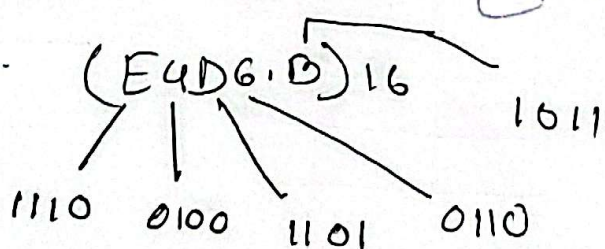
Q Determine the radix of the following number (Ans.)
 Fall-23-24 Q1A Convert the Hexadecimal number

E4D6.B to octal, decimal and binary numbers?

Q Perform the following conversion by using base 2 instead of base 10 as the intermediate base for the conversion:

$(103)_4$ to octal? (Ans.)

Soln. Given number,



$(111) = 8$ (Ans.)
 $(100) = 4$ (Ans.)
 1 6 2 3 2 6 5 4
 $(16232654)_8$

Octal to Decimal:-

$$1 \times 8^5 + 6 \times 8^4 + 2 \times 8^3 + 3 \times 8^2 + 2 \times 8^1 + 6 \times 8^0 + 5 \times 8^{-1} + 4 \times 8^{-2}$$

$$= 32768 + 24576 + 1024 + 192 + 16 + 6 + 0.625 + 0.0625$$

$$= 58582.03906 \quad (\text{Ans})$$

SoM - B

$$(134)_4 = 1 \times 4^2 + 3 \times 4^1 + 4 \times 4^0$$

$$= 16 + 12 + 4$$

$$= 32$$

$$(134)_4 = \begin{matrix} 1 & 3 & 4 \\ | & | & | \\ (01) & (00) & (11) \end{matrix}_2 = (010011)_2 = (23)_8 \quad (\text{Ans})$$



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



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

Lecture 04

Combinational Circuits

Binary no $\rightarrow$ Calculation (Boolean Algebra)

A=0

A=1

operation

Symbol

AND

OR

NOT

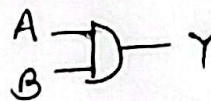
(Inversion gate)

$A=0 \rightarrow 1 = \bar{A}, \bar{A}'; A' \text{ (complement)}$

$1 \rightarrow 0$

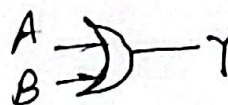
AND

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



OR

A	B	A+B
0	0	0
0	1	1
1	0	1
1	1	1



Universal gate :- 2 types :-

1) NAND gate :-



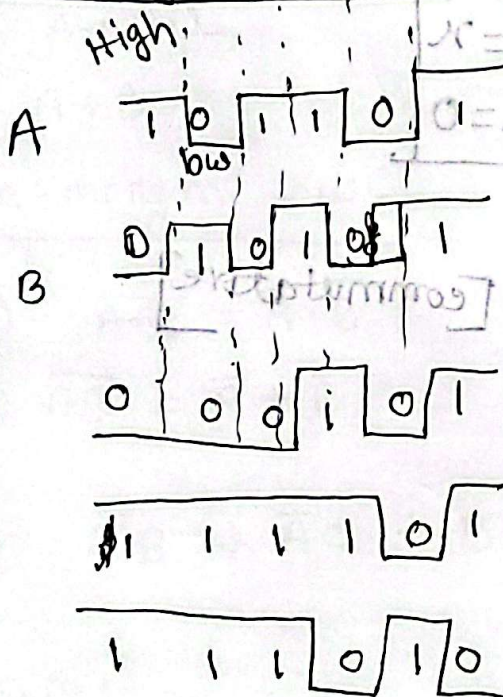
যেকোনো একটি 0 হলে
output 1.

2) NOR gate :-



দুইটা input 0 হলেই
কোন output 1 হবে।

⊕ Timing Diagram



$$\begin{aligned} 0 &= 0 \cdot 0 \\ 0 &= 1 \cdot 0 \\ 1 &= 1 \cdot 1 \\ 0 &= \bar{1} \cdot 1 \\ 1 &= \bar{0} \cdot 0 \end{aligned}$$

$$\begin{aligned} x &= 0 + x \\ 1 &= 1 + x \\ x &= x + x \\ 1 &= \bar{x} + x \end{aligned}$$

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

$$x + \bar{x} = 1$$

$$\begin{aligned} (x + y) \cdot (x + \bar{y}) &= x + y \cdot \bar{y} \\ &= x + 0 \\ &= x \end{aligned}$$

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

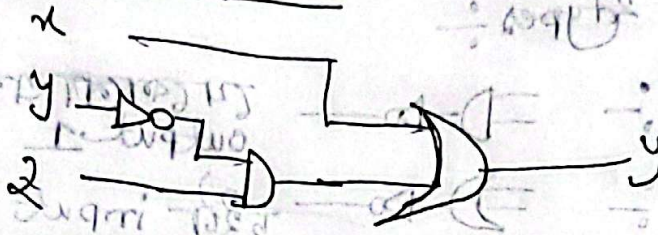
$$xy + \bar{x} \cdot \bar{y} = (x + \bar{x}) \cdot (y + \bar{y})$$

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

$$\oplus F = x + \bar{y}z$$

x	y	z	$\bar{y}$	$\bar{y}z$	$x + \bar{y}z$
0	0	0	1	0	0
0	0	1	1	1	1
0	1	0	0	0	0
0	1	1	0	0	0
1	0	0	1	0	1
1	0	1	1	1	1
1	1	0	0	0	1
1	1	1	0	0	1

Logic Diagram:



Boolean Algebra:

$$\begin{aligned} x + 0 &= x \\ x + 1 &= 1 \\ x + x &= x \\ x + \bar{x} &= 1 \end{aligned}$$

$$\begin{aligned} x \cdot 0 &= 0 \\ x \cdot 1 &= x \\ x \cdot x &= x \\ x \cdot \bar{x} &= 0 \end{aligned}$$

$$\begin{aligned} x + y &= y + x & xy &= yx \quad [\text{commutative}] \\ (x + y) + z &= x + (y + z) \\ \oplus (x + y)(x + z) \end{aligned}$$

$$= xx + xz + yx + yz$$

$$= x + xz + yx + yz$$

$$= x(1 + z + y) + yz$$

$$= x \cdot 1 + yz \quad [\text{একক আছে যে কোনো কিছু OR}]$$

$$= x + yz$$

সমাধানঃ Ans 1 হবে

	1	0	0	0
	0	0	1	0
	0	1	1	0
1	0	0	0	1
1	1	0	1	1
0	0	1	1	1
0	1	1	1	1

Lecture-05

$$\textcircled{\#} A + \bar{A}B$$

$$= A \cdot 1 + \bar{A}B$$

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

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

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

$$= A + B \cdot 1$$

$$= A + B$$

$$\textcircled{\#} A + AB$$

$$= A(1+B)$$

$$= A$$

$$\textcircled{\#} B + \bar{B}C = B + C$$

De-morgan law :-

$$\textcircled{1} \overline{A+B} = \bar{A} \cdot \bar{B}$$

$$\textcircled{2} \overline{AB} = \bar{A} + \bar{B}$$

$$\textcircled{\#} AB + \bar{A}C + BC = AB + \bar{A}C \quad (\text{consensus Theorem})$$

Soln :- L.H.S = $AB + \bar{A}C + BC$

$$= AB + \bar{A}C + 1 \cdot BC$$

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

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

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

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

$$= R.H.S$$

$$\therefore L.H.S = R.H.S \quad (\text{proved})$$

Q. $(\overline{x+y})z + x\bar{y} = \bar{y}(x+z)$ prove this?

Soln.

$$L.H.S = (\overline{x+y})z + x\bar{y}$$

$$= \bar{x}\bar{y}z + x\bar{y} \quad [\text{De-morgan}]$$

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

$$= \bar{y}(x+z) \quad [A + \bar{A}B = A + B]$$

$$= R.H.S$$

$\therefore L.H.S = R.H.S$ (proved)

Q. Solve this:

$$AB + \bar{A}CD + \bar{A}BD + \bar{A}C\bar{D} + AB\bar{C}D$$

$$= AB(1 + CD) + \bar{A}CD + \bar{A}BD + \bar{A}C\bar{D}$$

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

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

$$= AB + \bar{A}C + \bar{A}BD$$

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

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

$$= B(A+D) + \bar{A}C \quad [5 \text{ literals}]$$

$$\textcircled{\#} F = \bar{x}y\bar{z} + xy\bar{z} + \bar{F} = ?$$

Solⁿ:

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

$$= \overline{\bar{x}y\bar{z}} \cdot \overline{xy\bar{z}}$$

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

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

$$\textcircled{\#} F = AB + \bar{A}C + B\bar{C}$$

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

complement

~~Dual function~~

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

direct expression to complement

Dual function

without complement change
or to And / ~~or~~ AND to or

Self dual:

if $F = \text{self dual}$

$$\textcircled{\#} F = xy + yz + zx$$

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

e-T-2

20 marks
Saturday

Syllabus
আজকের class পরীক্ষা

Date: / /

$$F = (xy + xz + yz + yz) (z + x)$$

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

$$= (y(x + 1 + z) + xz) (z + x)$$

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

$$= yz + xy + xz + xz$$

$$= yz + xy + xz$$

$$= F$$

Dual function
Simplify
same Function
self dual.

∴ Dual function = main function.

∴ function is self dual. (Ans.)

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

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

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

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

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

$$= \bar{C} + A(BD) + \bar{A} \quad [\bar{A} + AB = A + B]$$

$$= \bar{C} + \bar{A} + BD \quad [\bar{A} + AB = \bar{A} + B]$$

[4 intervals]

(Ans.)

Lecture-06

prev. ques. slv^o⊙ Prove that: $AB + B\bar{C}\bar{D} + \bar{A}B\bar{C} + \bar{C}D = B + \bar{C}D$ Solⁿ

$$\text{L.H.S} = AB + B\bar{C}\bar{D} + \bar{A}B\bar{C} + \bar{C}D$$

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

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

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

$$= B(\bar{C} + \bar{C}) + AB + \bar{C}D \quad [A + \bar{A} = 1]$$

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

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

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

$$= \text{R.H.S}$$

$$\therefore \text{L.H.S} = \text{R.H.S} \quad (\text{proved})$$

Spring-23 :-

$$\bar{X}\bar{Y} + \bar{Y}\bar{Z} + X\bar{Z} + XY + Y\bar{Z} = \bar{X}\bar{Y} + X\bar{Z} + Y\bar{Z}$$

$$\therefore \text{L.H.S} = \bar{X}\bar{Y} + \bar{Y}\bar{Z} + X\bar{Z} + XY + Y\bar{Z}$$

$$= \bar{X}\bar{Y} + \bar{Y}\bar{Z}(1 + X) + X\bar{Z} + XY + Y\bar{Z}$$

$$= \bar{X}\bar{Y} + \bar{Y}\bar{Z} + X\bar{Y}\bar{Z} + X\bar{Z} + XY + Y\bar{Z}$$

$$= \bar{X}\bar{Y} + \bar{Y}\bar{Z} +$$

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

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

$$= \bar{x}\bar{y}(1+z) + xz(\bar{y}+1) + xy + y\bar{z} \quad [1+x=1]$$

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

$$= \bar{x}\bar{y} + xz + xy(z+\bar{z}) + y\bar{z} \quad [x+\bar{x}=1]$$

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

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

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

$$= R.H.S$$

$$\therefore L.H.S = R.H.S \quad (\text{proved})$$

⑥ complement

$$\text{complement of } f = A\bar{B} + \bar{A}B$$

$$= A\bar{B} + \bar{A}B \quad [\text{De-morgan}]$$

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

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

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

4th Q (5) $\rightarrow$ 20 Marks

⑧ BCD-Addition
1) ⑧ conversion

$\therefore$ complement $f = \text{Dual } f$. (Proved)

$$\textcircled{\text{X}} \quad \bar{x}y\bar{z} + x\bar{y}\bar{z}$$

$$F = (x + \bar{y} + z) \cdot (\bar{x} + y + z) \quad (\underline{\text{Ans!}})$$

⊕ Minterm & Maxterm

	A	B	minterm	Maxterm
0	0	0	$\overline{A}\overline{B}=m_0$	$A+B$
1	0	1	$\overline{A}B=m_1$	$A+\overline{B}$
2	1	0	$A\overline{B}=m_2$	$\overline{A}+B$
3	1	1	$AB=m_3$	$\overline{A}+\overline{B}$

→ represented by m

→ represented by m

Practice problem: — CT Syllabus

chapter-1 (7-11, 16-20)

chapter - 2 (1-4, 6-9)

Slide - 01 (whole)

Slide - 02 (page 1-24)

⑦ Binary to decimal

$$\textcircled{1} 1 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$= 64 + 0 + 0 + 8 + 4 + 0 + 1$$

$$= (77)_{10} \text{ (Ans.)}$$

$$\textcircled{2} 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3}$$

$$= 64 + 0 + 16 + 0 + 0 + 2 + 1 + 0.5 + 0 + 0.125$$

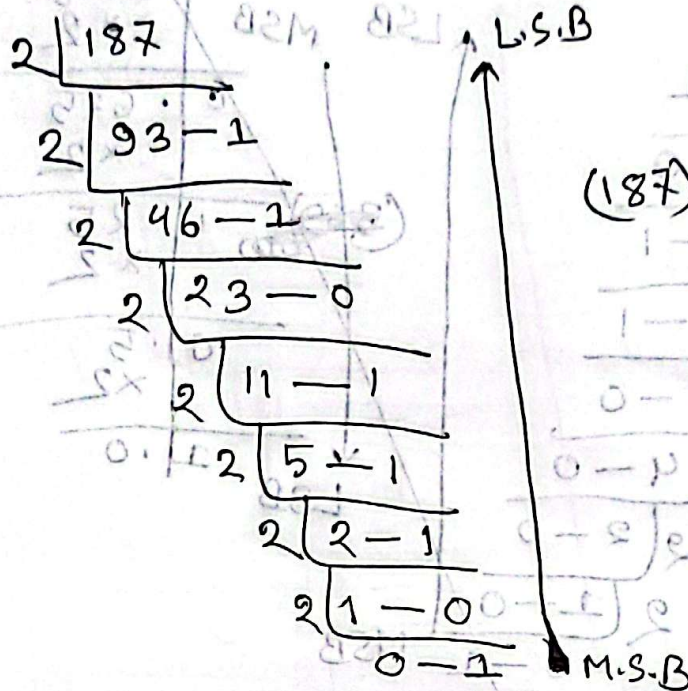
$$= (83.625)_{10} \text{ (Ans.)}$$

$$\textcircled{3} 1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 + 1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-4}$$

$$= 128 + 0 + 32 + 0 + 8 + 4 + 2 + 0 + 0.5 + 0 + 0.125 + 0.0625$$

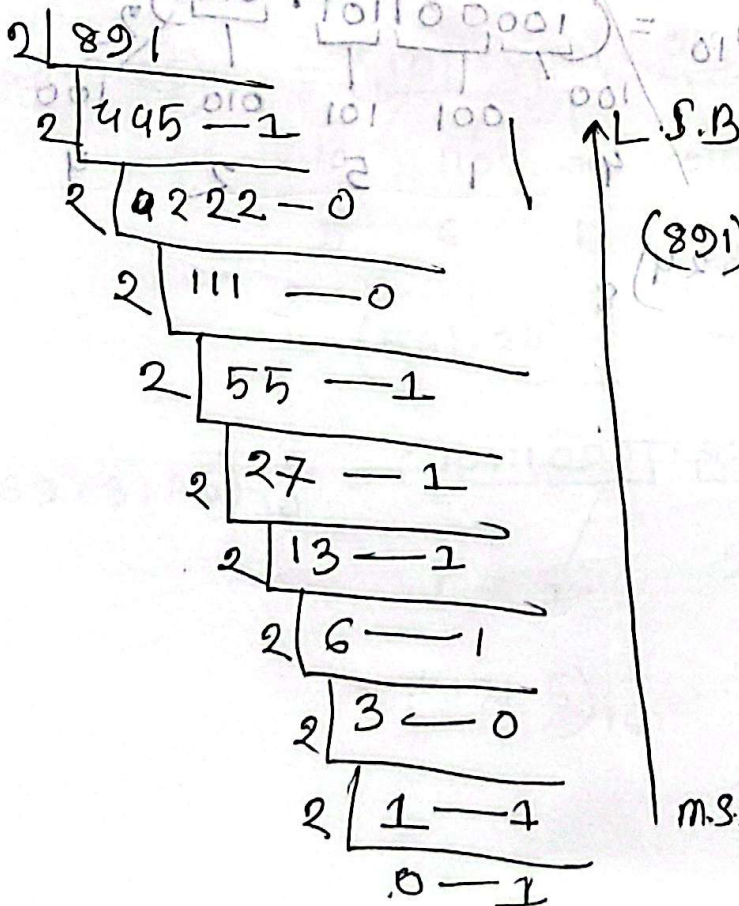
$$= (174.5625)_{10} \text{ (Ans.)}$$

⑧ ① Decimal to Binary conversion



$$(187)_{10} = (10111011)_2$$

⑨ ② Decimal to Binary conversion



$$(891)_{10} = (1101111001)_2$$

$$(378.75)_{10} = (101111010.11)_2 = (F28D)_{16}$$

⑩ Decimal to BCD Representation :-

①

$$\begin{array}{c} 715 \\ \swarrow \quad \downarrow \quad \searrow \\ 0111 \quad 0001 \quad 0101 \end{array} \quad \therefore (715)_{10} = (0111 \ 0001 \ 0101)_{BCD}$$

②

$$\begin{array}{c} 354 \\ \swarrow \quad \downarrow \quad \searrow \\ 0011 \quad 0101 \quad 0100 \end{array} \quad \therefore (354)_{10} = (0011 \ 0101 \ 0100)_{BCD}$$

⑪ Chapter-02 :-

$$\otimes XY = YX \quad [\text{commutative}]$$

$$\otimes X(YZ) = (XY)Z \quad [\text{Associative}]$$

$$\otimes X + YZ = (X + Y)(X + Z) \quad [\text{Distributive}]$$

$$\otimes \overline{X \cdot Y} = (\overline{X} + \overline{Y})$$

$$\otimes F = \overline{X} Y Z + \overline{X} Y \overline{Z} + X Z$$

$$= \overline{X} Y (Z + \overline{Z}) + X Z$$

$$= \overline{X} Y + X Z$$

(Ans.)

$$\textcircled{*} x + xy = x(1+y) = x$$

$$\textcircled{*} xy + xy' = x(y + \bar{y}) = x$$

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

$$\textcircled{*} x(x+y) = x \cdot x + xy = x + xy = x(1+y) = x$$

$$\begin{aligned} \textcircled{*} (x+y)(x+\bar{y}) &= xx + x\bar{y} + xy + y\bar{y} \\ &= x + x\bar{y} + xy \\ &= x(1 + \bar{y} + y) = x \end{aligned}$$

$$\begin{aligned} \textcircled{*} (x+y)(x+\bar{y}) &= x + x\bar{y} + y\bar{y} + xy \\ &= x + x(\bar{y} + y) \\ &= x \end{aligned}$$

$$\begin{aligned} \textcircled{*} xy + \bar{x}z + yz &= xy + \bar{x}z + yz(x + \bar{x}) \\ &= xy + \bar{x}z + xyx + \bar{x}yz \\ &= xy(1+z) + \bar{x}z(1+y) \\ &= xy + \bar{x}z \end{aligned}$$

$$\begin{aligned} \textcircled{*} (x+y)(\bar{x}+z)(y+z) &= (x+y)(\bar{x}y + \bar{x}z + z + yz) \\ &= (x+y)(\bar{x}y + z(\bar{x} + 1 + y)) \\ &= (x+y)(\bar{x}y + z) \\ &= x\bar{x}y + xz + \bar{x}yy + yz \\ &= xz + \bar{x}y + yz \end{aligned}$$

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

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

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

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

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

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

$$= A\bar{B} + \bar{A}B \quad (\text{Ans.})$$

⊕ Complementing Function by using dual:-

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

dual form,

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

complementing each literal, we have,

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

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

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

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

Exercise: SOM ① (a) Validity of De-morgan theorem:

X	Y	$\bar{X}$	$\bar{Y}$	$\overline{XY}$	$\bar{X} + \bar{Y}$
0	0	1	1	1	1
0	1	1	0	1	1
1	0	0	1	1	1
1	1	0	0	0	0

आकिडूना - same type 1

② 2.2: ① $\bar{X} + \bar{Y} = \overline{XY}$ proof?

$$\begin{aligned}
 \text{L.H.S} &= \bar{X} + \bar{Y} \\
 &= \bar{X} + \bar{Y} \cdot (X + \bar{X}) \\
 &= \bar{X} + \bar{X}Y + \bar{Y} \\
 &= \bar{X} + \bar{Y} \quad [\text{A} + \bar{A}B = A + B]
 \end{aligned}$$

$\therefore \text{L.H.S} = \text{R.H.S} \text{ (proved)}$

⑥ prove that $\bar{A}B + \bar{B}\bar{C} + AB + \bar{B}C = 1$

Soln.

$$\begin{aligned} \text{L.H.S} &= \bar{A}B + \bar{B}\bar{C} + AB + \bar{B}C \\ &= B(A + \bar{A}) + \bar{B}(\bar{C} + C) \\ &= B + \bar{B} \\ &= 1 = \text{R.H.S} \end{aligned}$$

$\therefore \text{L.H.S} = \text{R.H.S}$ (proved)

⑦ $X + \bar{X}Z + X\bar{Y} = X + Y + Z$ prove this?

Soln.

$$\text{L.H.S} = X + \bar{X}Z + X\bar{Y}$$

$$\begin{aligned} &= X + \bar{X}Z(Y + \bar{Y}) + X\bar{Y} \\ &= X + \bar{X}ZY + \bar{X}Z\bar{Y} + X\bar{Y} \\ &= X(1 + \bar{X}Z) + \bar{X}\bar{Y}Z + X\bar{Y} \\ &= X \end{aligned}$$

$$= X + X\bar{Y} + \bar{X}Z + \bar{X}Z\bar{Y}$$

$$= (X + X\bar{Y}) + \bar{X}Z$$

$$= (X + X) + \bar{X}Z$$

$$= X + (X + \bar{X})Z$$

$$= X + 1 \cdot Z$$

$$= X + Z$$

$$= X + Y + Z = \text{R.H.S}$$

Q. $\bar{x}\bar{y} + \bar{y}z + xz + xy + y\bar{z} = \bar{x}\bar{y} + xz + y\bar{z}$ prove this?

So^mo

$$L.H.S = \bar{x}\bar{y} + \bar{y}z + xz + xy + y\bar{z}$$

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

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

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

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

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

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

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

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

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

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

$$= R.H.S$$

$$\therefore L.H.S = R.H.S \text{ (proved)}$$

Q. prove that, $AB\bar{C} + B\bar{C}\bar{D} + BC + \bar{C}D = B + \bar{C}D$

So^mo

$$L.H.S = AB\bar{C} + B\bar{C}\bar{D} + BC + \bar{C}D$$

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

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

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

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

$$= AB(1 + c) + B\bar{c}\bar{D} + \bar{c}BD + \bar{c}\bar{B}D$$

$$= AB + B\bar{c}\bar{D} + \bar{c}BD + \bar{c}\bar{B}D$$

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

$$= AB + B\bar{c} + \bar{c}\bar{B}D$$

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

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

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

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

③ (a) Prove that $AB\bar{c} + B\bar{c}\bar{D} + Bc + \bar{c}D = B + \bar{c}D$

So m.o. L.H.S = $AB\bar{c} + B\bar{c}\bar{D} + Bc + \bar{c}D$

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

$$= AB\bar{c} + B\bar{c}\bar{D} + ABc + \bar{A}Bc + B\bar{c}D + \bar{B}\bar{c}D$$

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

$$= AB + B\bar{c} + \bar{A}Bc + \bar{B}\bar{c}D$$

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

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

$$= AB + Bc + B\bar{c} + \bar{c}D$$

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

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

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

$$= B + \bar{C}D = R.H.S$$

$$\therefore L.H.S = R.H.S \text{ (proved)}$$

(b) Prove that $\omega y + \bar{\omega} y \bar{z} + \omega x z + \bar{\omega} x \bar{y} = \omega y + \bar{\omega} x \bar{z} + \bar{x} y \bar{z} + x \bar{y} z$

$$\text{Soln} \therefore L.H.S = \omega y + \bar{\omega} y \bar{z} + \omega x z + \bar{\omega} x \bar{y}$$

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

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

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

$$\bar{\omega} x \bar{y} \bar{z}$$

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

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

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

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

$$2 \cdot 1 \cdot 2 =$$

$$(proved) \therefore L.H.S = R.H.S$$

$$\textcircled{2} \quad A\bar{D} + \bar{A}B + \bar{C}D + \bar{B}C = (\bar{A} + \bar{B} + \bar{C} + \bar{D})(A + B + C + D)$$

Soln.

$$\text{L.H.S} = A\bar{D} + \bar{A}B + \bar{C}D + \bar{B}C$$

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

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

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

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

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

$$= \bar{A}B\bar{C}D + 0 + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} + AD\bar{C}D + AD\bar{C}\bar{D} + BD\bar{C}D + BD\bar{C}\bar{D} + \bar{D}\bar{C}D + \bar{D}\bar{C}\bar{D}$$

$$= \bar{A}B\bar{C}D + 0 + \bar{A}B\bar{C}\bar{D} + \bar{A}B\bar{C}\bar{D} + AD\bar{C}D + AD\bar{C}\bar{D} + BD\bar{C}D + BD\bar{C}\bar{D} + \bar{D}\bar{C}D + \bar{D}\bar{C}\bar{D}$$

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

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

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

$$= \text{R.H.S}$$

$$\therefore \text{L.H.S} = \text{R.H.S} \quad (\text{proved})$$

$$\begin{aligned}
 \textcircled{4} \text{ L.H.S} &= (A+c) \cdot (\bar{A}+B) \cdot (B+c) \\
 &= (AA + AB + \bar{A}c + Bc) (B+c) \\
 &= (AB + \bar{A}c + Bc) (B+c) \\
 &= AB \cdot B + \bar{A}Bc + Bc + ABc + \bar{A}c + Bc \\
 &= AB + Bc(\bar{A}+1) + Bc(A+1) + \bar{A}c \\
 &= AB + Bc + Bc + Ac \\
 &= AB + Bc + Ac \\
 &= AB + c(A+B)
 \end{aligned}$$

$$\begin{aligned}
 \textcircled{4} \text{ L.H.S} &= (A+c) (\bar{A}+B) (B+c) \\
 &= (A\bar{A} + AB + \bar{A}c + Bc) (B+c) \\
 &= (\bar{A} + 1) (B+c) \\
 &= AB + \bar{A}Bc + Bc + ABc + \bar{A}c \\
 &= AB + Bc(A+\bar{A}) + Bc + \bar{A}c \\
 &= AB + Bc + \bar{A}c \\
 &= c(\bar{A}+B) \cdot 1 \\
 &= c(\bar{A}+B)(A+\bar{A}) \\
 &= c(A\bar{A} + AB + \bar{A}B + B\bar{B}) \\
 &= c(B(A+\bar{A})) = Bc = R.H.S
 \end{aligned}$$

$$\begin{aligned}
 & \textcircled{a} BC + B(AD + \bar{E}D) \\
 &= BC + ABD + B\bar{E}D \\
 &= BC(1 + D) + ABD + B\bar{E}D \\
 &= BC + BCD + ABD + B\bar{E}D \\
 &= BC + BD(C + \bar{E}) + ABD \\
 &= BC + BD \cdot 1 + ABD \\
 &= BC + BD(1 + A) \\
 &= B(C + D) \quad (\underline{\text{Ans}})
 \end{aligned}$$

$$\begin{aligned}
 & \textcircled{b} (B + \bar{E} + B\bar{E})(BC + A\bar{B} + A\bar{C}) \\
 &= B + \bar{E} + B\bar{E} \cdot BC + B\bar{E}A\bar{B} + B\bar{E}A\bar{C} \\
 &= (B + \bar{E} + 0 + 0 + 0) + (B + \bar{C} + A\bar{B} + A\bar{C}) \\
 &= (B + \bar{E})(BC + A\bar{B} + A\bar{C}) \\
 &= B \cdot BC + A\bar{B}B + AB\bar{C} + B\bar{E}\bar{C} + A\bar{B}\bar{E} + A\bar{C}\bar{E} \\
 &= BC + 0 + AB\bar{C} + 0 + A\bar{B}\bar{E} + 0 \\
 &= BC(1 + A) + A\bar{B}\bar{E} \\
 &= BC + A\bar{B}\bar{E} \quad (\underline{\text{Ans}})
 \end{aligned}$$

② Using De-morgan (only or and complement)

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

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

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

(Ans)

③

a

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

∴ Complement of $F = \bar{F}$

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

$$= (\overline{A+B}) \cdot (\overline{A+B})$$

(Ans)

b

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

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

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

$$= (\bar{v} + w) \bar{x} + \bar{y}z \quad (\text{Ans})$$

$$c) wx(\bar{y}z + y\bar{z}) + \bar{w}\bar{x}(\bar{y} + z)(y + \bar{z})$$

complement of function =

$$\textcircled{3} \textcircled{b} WY + \bar{W}Y\bar{z} + WXz + \bar{W}X\bar{Y}$$

$$= WY + \bar{W}Y\bar{z}(x + \bar{x}) + WXz(Y + \bar{Y}) + \bar{W}X\bar{Y}(z + \bar{z})$$

$$= WY + \bar{W}Yx\bar{z} + \bar{W}\bar{x}Y\bar{z} + \underline{WXYz} + \bar{W}X\bar{Y}z + \bar{W}X\bar{Y}\bar{z} + \underline{\bar{W}X\bar{Y}z}$$

$$= WY(1 + x\bar{z}) + \bar{W}x\bar{z}(Y + \bar{Y}) +$$

previous year question solr^o

$$\begin{array}{r} 2 \overline{) 30} \\ 3 \overline{) 15} \\ 5 \end{array}$$

Summer-23^o

$$\textcircled{1} \textcircled{A} (234)_n + (12)_n = (66)_n$$

$$\Rightarrow 2 \times n^2 + 3 \times n^1 + 4 \times n^0 + 1 \times n^1 + 2 \times n^0 = 6 \times n^1 + 6 \times n^0$$

$$\Rightarrow 2n^2 + 3n + 4 + n + 2 = 6n + 6$$

$$\Rightarrow 2n^2 + 3n + 6 = 5n + 6$$

$$\Rightarrow 2n^2 + 3n = 5(2n + 3)$$

$$\Rightarrow 2n^2 + 3n = 10n + 15$$

$$\Rightarrow 2n^2 - 7n - 15 = 0$$

$$\Rightarrow 2n^2 - 10n + 3n - 15 = 0$$

$$\Rightarrow 2n(n - 5) + 3(n - 5) = 0$$

$$\Rightarrow (n - 5)(2n + 3) = 0$$

$$\therefore n = 5$$

$$x = 2n + 3 = 2 \times 5 + 3 = 10 + 3 = 13$$

lecture - 07

A	B	C	minterm	minterm $\frac{\circ}{\circ}$
0	0	0	m_0	$m_4 = A\bar{B}\bar{C} = m_0$
0	0	1	m_1	
0	1	0	m_2	$m_7 = \bar{A}B\bar{C}$
0	1	1	m_3	
1	0	0	m_4	
1	0	1	m_5	
1	1	0	m_6	
1	1	1	m_7	

Maxterm $\frac{\circ}{\circ}$

$M_3 = A + \bar{B} + \bar{C}$

⊕ Write the minterm expression, F from the truth table

	A	B	C	F ₂
$m_0 \leftarrow$	0	0	0	0
	0	0	1	1
$m_2 \leftarrow$	0	1	0	0
$m_3 \leftarrow$	0	1	1	0
	1	0	0	1
$m_5 \leftarrow$	1	0	1	0
	1	1	0	1
$m_7 \leftarrow$	1	1	1	0

$F_2 = \text{minterm}$

= sum of product (SOP)

minterm

$= m_1 + m_4 + m_6$

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

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

$= \sum (m_1, m_4, m_6)$

$m_4 = A\bar{B}\bar{C}$

$m_6 = AB\bar{C}$

⊕ Maxterm: Product of sum / product of Maxterm (POS)

$$F_2 = M_0 \cdot M_2 \cdot M_3 \cdot M_5 \cdot M_7$$

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

$$= \pi(M_0, M_2, M_3, M_5, M_7)$$

Lecture-08

Date: 18-03-25

SOP:

$$F_2(A, B, C, D, E) = m_2 + m_9 + m_{17} + m_{23}$$

$$= A'B'e'DE' + A'Be'D'E + AB'e'D'E + AB'e'DE$$

⊕ Maxterm:

$$F(A, B, C, D) = M_3 \cdot M_8 \cdot M_{11} \cdot M_{14}$$

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

কোনো element যুক্ত মinterm.

⊕ Canonical $\frac{0}{F(M) \cdot \bar{C}(M) \cdot \bar{B}(M) \cdot A(M) \cdot D(M) = \bar{A}}$

⊕ Non-canonical $\frac{(A+B+C) \cdot (A+\bar{B}+A) \cdot (A+B+A)}{(A+B+C)}$

$F(A,B,C) = A\bar{B}C + AB\bar{C} + ABC$ $F(A,B,C) = AB + B\bar{C} + BCA$

⊕ প্রত্যেক variable present $\frac{F(M) \cdot \bar{C}(M) \cdot \bar{B}(M) \cdot A(M) \cdot D(M)}{F(M) \cdot \bar{C}(M) \cdot \bar{B}(M) \cdot A(M) \cdot D(M)} = 1$ $\frac{0}{\text{প্রত্যেক variable present থাকে}}$

থাকবে. (All term)

ques. type $\frac{0}{\text{Non-canonical to canonical Form conversion}}$

Non-canonical $\rightarrow$ canonical sop $\frac{0}{\text{Non-canonical to canonical sop}}$

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

$P = m_3 + m_2 + m_0$
 $= \sum (m_0, m_2, m_3)$
 $= \pi(M_2)$
 $= (x + \bar{y})$

$$\textcircled{\#} F = A + \bar{B}C$$

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

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

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

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

$$= \boxed{m_0 + m_2} = m_7 + m_5 + m_6 + m_4 + m_1$$

$$= \sum (m_1, m_4, m_5, m_6, m_7)$$

$$= \prod (M_0, M_2, M_3)$$

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

Summer-23 :- Using Boolean algebra convert the following function into sum-of-product and pos form.

$$\textcircled{a} \quad \bar{x} + x(x + \bar{y})(\bar{x}y + \bar{z})$$

$$\textcircled{b} \quad \text{prove that } AB + B\bar{C}\bar{D} + \bar{A}B\bar{C} + \bar{C}D = B + \bar{C}D$$

Soln.

$$\textcircled{a} \quad \bar{x} + x(x + \bar{y})(xy + \bar{z})$$

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

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

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

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

$$= \bar{x}Yz + \bar{x}Y\bar{z} + \bar{x}\bar{y}z + \bar{x}\bar{y}\bar{z} + xYz + xY\bar{z} + x\bar{y}z + x\bar{y}\bar{z}$$

$$= \bar{x}Yz + xY\bar{z} + \bar{x}\bar{y}\bar{z} + \bar{x}\bar{y}z + \bar{x}\bar{y}\bar{z} + xYz$$

$$= m_4 + m_6 + m_3 + m_2 + m_1 + m_7 + m_0$$

$$= m_5$$

$$\textcircled{b} \quad (\bar{x} + yx + \bar{z})(\bar{y} + x + \bar{x})$$

$$\textcircled{c} \quad \bar{A}B + B\bar{C}D + AB + \bar{C}D = \bar{A}B + B\bar{C}D + AB + \bar{C}D$$

For shortcut:-

$\bar{x}$	$\square$	$\square$	$+ x y \square$	$+ x \bar{y} \bar{z}$
0	0	0	1	0
0	0	1	1	1
0	1	0		
0	1	1		

Summer-24 H.W.

$$(A+B)(A+C)(AB'e)$$

$$= (AA+AC+AB+BC)AB'e$$

$$= A \cdot AB'e + AC \cdot AB'e + AB \cdot AB'e + BC \cdot AB'e$$

$$= AB'e + AB'e + 0 + 0$$

$$= \overset{4}{A} \overset{2}{B} \overset{1}{e}$$

$$= m_5$$

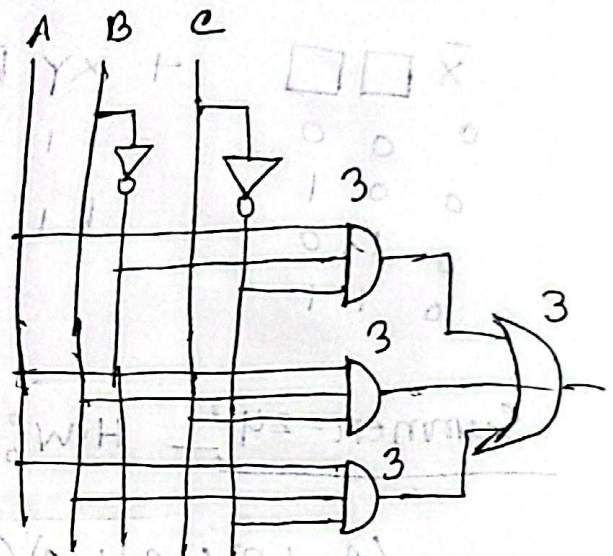
$$= \pi (M_0, M_1, M_2, M_3, M_4, M_6, M_7)$$

Lecture - 09

K-map (Karnaugh map)

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

Literal = 9

Gate input: $G_i = 12$ 

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

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

$$L = 5$$

$$G_i = 7$$

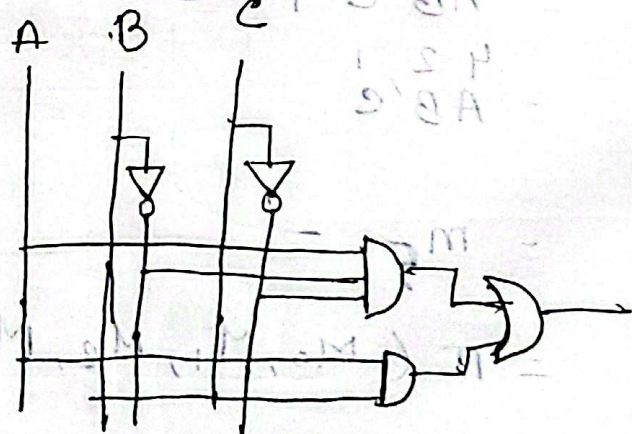
$$\Rightarrow A(\bar{B}\bar{C} + B)$$

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

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

$$L = 4$$

$$G_i = 6$$



K-map (3 variable) :

K-map 4 MSB 2 MSB

	BC	00	01	11	10
A	00	m ₀	m ₁	m ₃	m ₂
0	0	0	0	0	0
1	0	1	0	1	1

AB Group of Adjacent 1's (group of 2, 4, 6, 8, 16)

Rules :

- ① Make Group of Adjacent 1's (group of 2, 4, 6, 8, 16)
- ② Try to cover all 1's using minimum group.
- ③ Overlapping of group is allowed.

$\therefore F = AB + A\bar{B}$ [K-map থেকে সরাসরি simplify
করা যায়]

⊕ $F_2 = \sum (0, 1, 5, 7)$

	BC	00	01	11	10
A	00	m ₀	m ₁	m ₃	m ₂
0	0	1	1	0	0
1	0	0	1	1	0

⊕ সবগুলো 1 গ্রুপ এ চলে আসলে আর গ্রুপ করা
দরকার নেই।

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

$$\oplus F_2 = \sum (0, 1, 3, 5)$$

A \ BC	00		01		11		10	
	m ₀	m ₁	m ₂	m ₃	m ₄	m ₅	m ₆	m ₇
0	1	1	1	0	0	0	0	0
1	0	1	0	1	0	0	0	0

$$\therefore F = A'B' + A'C + B'C$$

$$\oplus F_4 = \sum (0, 2, 4, 6)$$

A \ BC	00		01		11		10	
	m ₀	m ₁	m ₂	m ₃	m ₄	m ₅	m ₆	m ₇
0	1	0	1	0	0	0	1	0
1	1	0	0	1	1	0	0	1

$$F_4 = \bar{C}$$

3-variable k-map

2 variable group $\rightarrow$ 1 variable reduce

4 " group $\rightarrow$ 2 " (2) " group

8 " " $\rightarrow$ 3 " "

* यदि अवशेष variable 1 है

उत्तर Ans 1 है ।

A \ B C	00	01	11	10
0	1	1	1	1
1	1	1	1	1

→ Ans: 1

⊕ $F_5 = \Sigma (0, 1, 2, 4, 5, 6)$

A \ B C	00	01	11	10
0	1	1	1	1
1	1	1	1	1

$F_5 = \bar{B} + \bar{C}$

max term

⊕ $F_2 = \Pi (3, 7) = \bar{B}\bar{C} = \bar{B} + \bar{C}$

A \ B C	00	01	11	10
0	1	1	0	1
1	1	1	0	1

1100
8421

Date: 22/03/25

AB \ CD	00	01	11	10
00	0	0	0	0
01	0	1	1	0
11	0	1	1	0
10	0	0	0	0

→ BD

$$F_1 = \sum (5, 7, 13, 15) = BD$$

$$\oplus F_2 = \sum (1, 3, 4, 6, 11, 12, 14)$$

AB \ CD	00	01	11	10
00	0	1	1	0
01	1	0	0	0
11	1	0	0	0
10	0	1	1	0

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

$$F = B\bar{D} + D\bar{B} = B \oplus D$$

$$\textcircled{\#} F_3 = \sum (0, 2, 5, 9, 15)$$

AB \ CD	00	01	11	10
00	1 m_0	0 m_1	0 m_3	1 m_2
01	0 m_4	1 m_5	0 m_7	0 m_6
11	0 m_{12}	0 m_{13}	1 m_{15}	0 m_{14}
10	0 m_8	0 m_9	0 m_{11}	0 m_{10}

$$F = A'B'D' + A'Be'D + AB'eD + AB'e'D$$

$$\textcircled{\#} F_4 = \sum (1, 8, 9, 10)$$

AB \ CD	00	01	11	10
00	0 m_0	1 m_1	0 m_3	0 m_2
01	0 m_4	0 m_5	0 m_7	0 m_6
11	0 m_{12}	0 m_{13}	0 m_{15}	0 m_{14}
10	1 m_8	1 m_9	0 m_{11}	1 m_{10}

$$F = \boxed{A'B'D'} + A'B'D' + \cancel{A'B'e'D} + B'e'D$$

10-15 ମାର୍ଚ୍ଚ BCD ଡେ କାଣ୍ଡେ ଆସେ ନା 50 don't care ଏହୁମାନ ।

$$\textcircled{\#} F_1(A, B, C) = \sum (0, 1, 3, 5) + d(2, 4)$$

A \ BC	BC			
	00	01	11	10
0	1 m_0	1 m_1	1 m_3	1 m_2
1	1 m_4	1 m_5	0 m_7	0 m_6

$$\therefore F = A' + B' \quad (\text{Ans})$$

$$F_2 = (A, B, CD) = \sum (5, 6, 9, 13, 15) + d(1, 7, 14)$$

So m =

AB \ CD	CD			
	00	01	11	10
00	0 m_0	1 m_1	0 m_3	0 m_2
01	0 m_4	1 m_5	1 m_7	1 m_6
11	0 m_{12}	1 m_{13}	1 m_{15}	1 m_{14}
10	0 m_8	1 m_9	0 m_{11}	0 m_{10}

$$F = \bar{C}D + BC$$

$$\text{POS}^\circ \quad F_2 = \pi (0, 2, 3, 4, 8, 10, 11, 12) + d(1, 7, 14)$$

	CD	00	01	11	10
AB		m ₀	m ₁	m ₃	m ₂
00		0	d	0	0
01		0	1	d	1
11		0	1	d	1
10		0	1	0	0

$\rightarrow C+D$ (grouping m₀, m₄, m₈, m₁₂)
 $\rightarrow B+\bar{C}$ (grouping m₁, m₅, m₉, m₁₃)

$$F_2 = (B+\bar{C})(C+D)$$

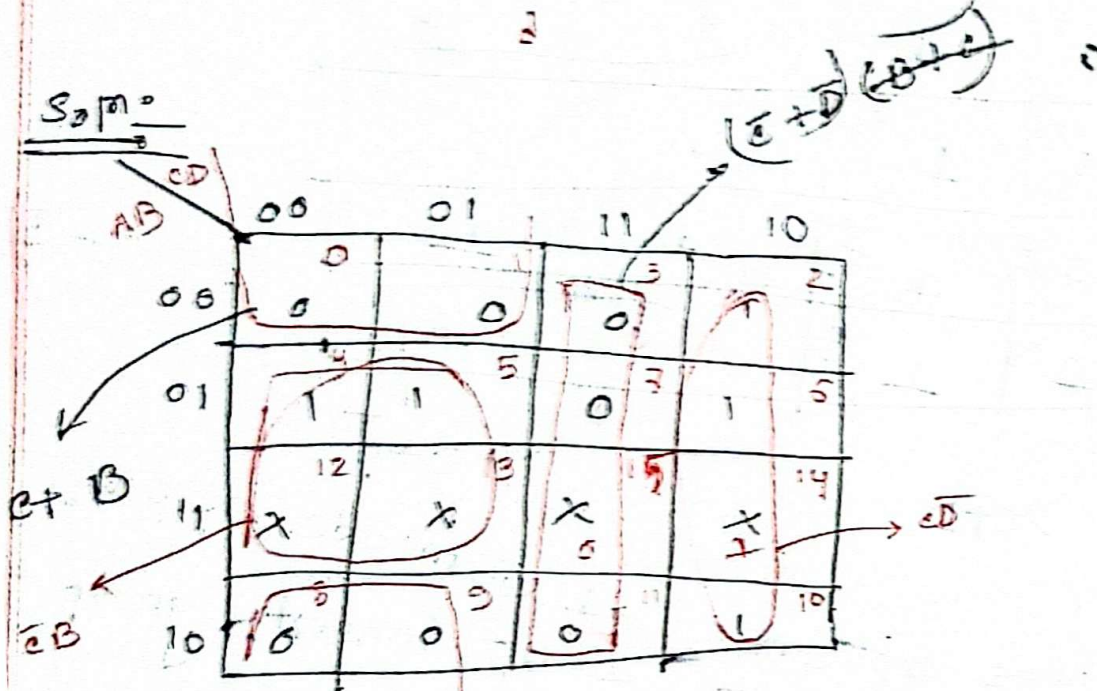
⊕ Prime implicant^o → 1-এর include বাবীত অন্য 1-এর largest group

prime implicant .

⊕ Essential prime implicant^o → এটি prime implicant যা অন্য prime implicant থাকে এবং একমুখিক prime implicant থাকে না এটি — Essential prime implicants .

Spring - 24°

$$F(A, B, C, D) = \prod (0, 1, 5, 7, 8, 9, 11) + \sum (12, 13, 14, 15)$$



$$F = (\bar{C} + D)(B + C) \quad [POS]$$

$$F = B\bar{C} + \bar{C}D \quad [SOP]$$

Here both need number of gate and literal are equal.

Date : _____

Q5 (b) $F = \sum (0, 2, 4, 5, 8, 14, 16) + \sum_d (7, 10, 13)$

Som^o cd.

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

- (i) prime implicant
(ii) Essential prime implicant.

Som^o → (i) prime implicant^o

- (i) $\bar{B} \bar{D}$
- (ii) $\bar{A} \bar{C} \bar{D} \bar{A}$
- (iii) $\bar{A} B \bar{C}$
- (iv) BD
- (v) $AB \bar{C}$
- (vi) $A \bar{C} \bar{D}$

(ii) Essential prime implicant^o

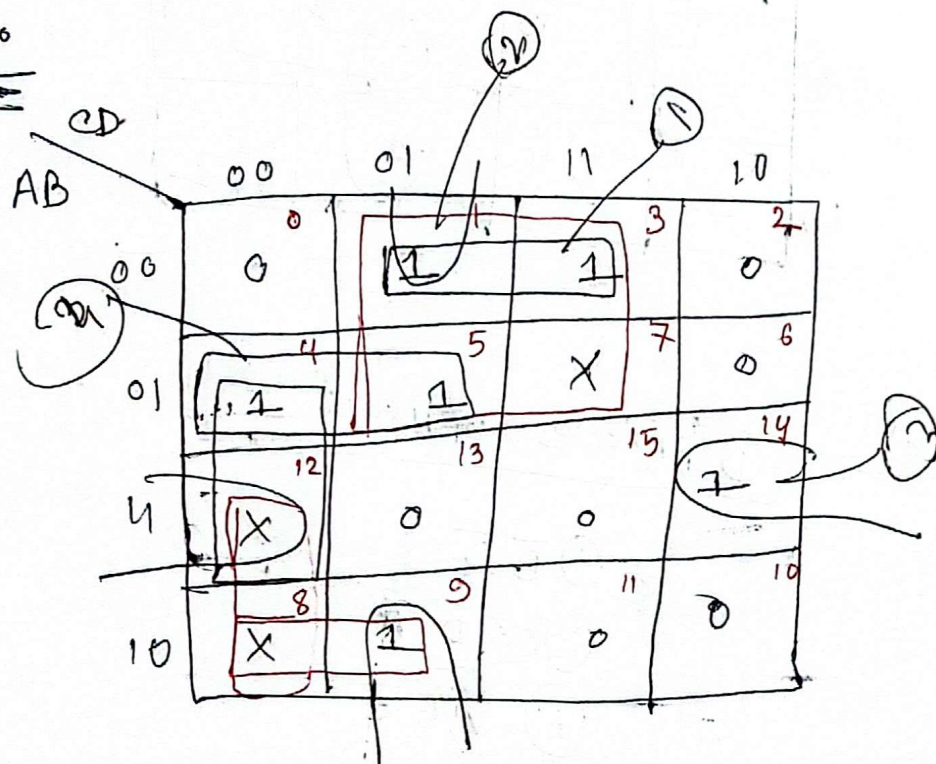
- (i) $\bar{B} \bar{D}$

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

$$\textcircled{1} F(A, B, C, D) = \sum_m (1, 3, 4, 5, 9, 14) +$$

$$\sum_d (7, 8, 12)$$

Som.



prime implicant

$$\textcircled{i} \bar{A}\bar{B}D$$

$$\textcircled{iv} \bar{A}B\bar{C}$$

$$\textcircled{ii} \bar{A}\bar{C}D$$

$$\textcircled{vi} A\bar{B}\bar{D}$$

$$\textcircled{iii} A\bar{D}$$

$$\textcircled{vii} \bar{A}B\bar{D}$$

$$\textcircled{v} \bar{B}\bar{C}D$$

$$\textcircled{viii} A\bar{C}D$$

$$\textcircled{ix} \bar{A}\bar{B}\bar{C}$$

Essential prime implicant:

① $AB\bar{D}$

~~② $\bar{A}\bar{B}\bar{C}D$~~ ③ $\bar{B}\bar{C}D$

④ $\bar{A}B\bar{C}$

For expression:

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

Spring-23 Design problem:

8 7 2 1.

$0000 \rightarrow 1$

$0001 \rightarrow 0$

$0010 \rightarrow 0$

$0011 \rightarrow 0$

$0100 \rightarrow 0$

$0101 \rightarrow 0$

$0110 \rightarrow 1$

$0111 \rightarrow 0$

$1000 \rightarrow 0$

$1001 \rightarrow 1$

$1010 \rightarrow 0$

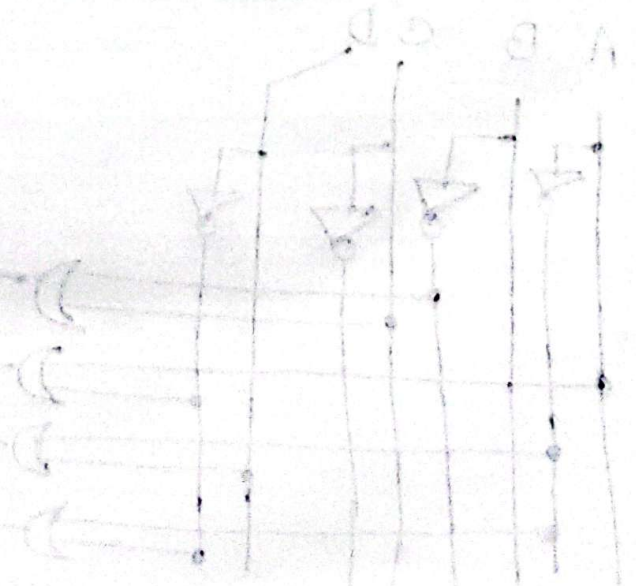
$1011 \rightarrow 0$

$1100 \rightarrow 0$

$1101 \rightarrow 0$

$1110 \rightarrow 0$

$1111 \rightarrow 1$

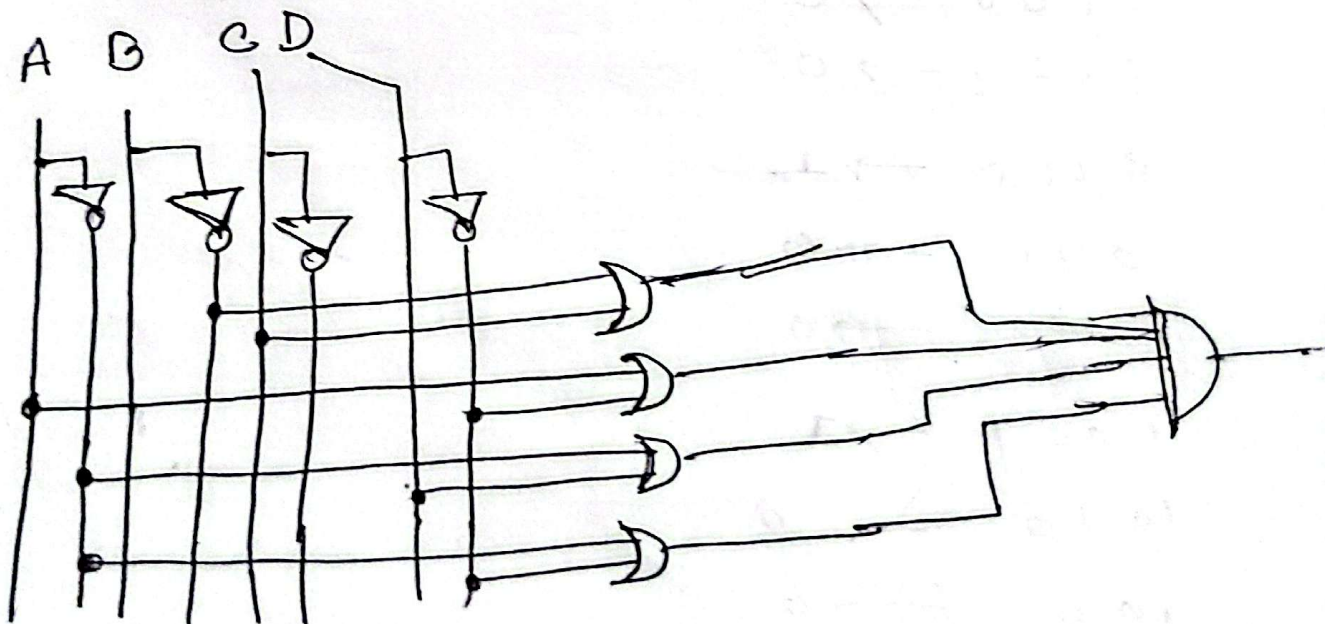


i) $\Sigma (0, 6, 9, 16)$
 $\Pi (1, 2, 3, 4, 5, 7, 8, 10, 11, 12, 13, 14)$

AB \ CD	00	01	11	10
00	1	0	0	0
01	0	0	0	1
10	0	0	1	0
11	0	1	0	0

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

iii) Circuit Diagram:-



spring - 23rd - 2nd

Grouping for K-map

0000 — 0

0001 — 0

0010 — 0

0011 — X

0100 — 0

0101 — X

0110 — X

0111 — 1

1000 — 0

1001 — X

1010 — X

1011 — 1

1100 — X

1101 — 1

1110 — 1

1111 — 1

(0-1) एकल एकल शून्य

→ 0

एकल (1-0) एकल एकल

शून्य → 1

एकल एकल

एकल एकल

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A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

A	B	C	F
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

preparation for mid CT

⊕ Making group in k-Map :-

Rules :- ① Make the group of adjacent 1s (Group of 2, 4, 8, 16 etc)

② Try to cover all the 1s using minimum number of groups.

③ Overlapping of the group is allowed.

④ Consider those minterms individually, which cannot be grouped with other minterms.

⊕ Karnaugh Map (k-map) :-

⊕ 3-Variable k-map :-

$$F_1 = \sum (0, 1, 5, 7) = \bar{A}\bar{B} + AC$$

	A	B	C	F
m ₀	0	0	0	1
m ₁	0	0	1	1
m ₂	0	1	0	0
m ₃	0	1	1	0
m ₄	1	0	0	0
m ₅	1	0	1	1
m ₆	1	1	0	0
m ₇	1	1	1	1

A \ BC	B'C	B'C'	BC	BC'
A'0	1 m ₀	1 m ₁	0 m ₃	0 m ₂
A'1	0 m ₄	1 m ₅	1 m ₇	0 m ₆

② Minimization of 3 variable k-map :-

$$F = \sum (0, 2, 4, 6) = c'$$

A \ BC	00	01	11	10
0	1 m_0	0 m_1	0 m_3	1 m_2
1	1 m_4	0 m_5	0 m_7	1 m_6

③ $F = \sum (0, 1, 3, 5) = A'B' + A'e + B'e$

A \ BC	00	01	11	10
0	1 m_0	1 m_1	1 m_3	0 m_2
1	0 m_4	1 m_5	0 m_7	0 m_6

④ $F = \sum (0, 1, 2, 4, 5, 6) = c' + B'$

A \ BC	00	01	11	10
0	1 m_0	1 m_1	0 m_3	1 m_2
1	1 m_4	1 m_5	0 m_7	1 m_6

⊕ 4-variable k-map $F = \sum (5, 7, 13, 15)$

AB \ CD	00	01	11	10
00	0 m_0	0 m_1	0 m_3	0 m_2
01	0 m_4	1 m_5	1 m_7	0 m_6
11	0 m_{12}	1 m_{13}	1 m_{15}	0 m_{14}
10	0 m_8	0 m_9	0 m_{11}	0 m_{10}

$$\therefore F = BD$$

⊕ Minimization of 4-variable k-map $F = \sum (1, 3, 4, 6, 12, 14, 9, 11)$

AB \ CD	00	01	11	10
00	0 m_0	1 m_1	1 m_3	0 m_2
01	1 m_4	0 m_5	0 m_7	1 m_6
11	1 m_{12}	0 m_{13}	0 m_{15}	1 m_{14}
10	0 m_8	1 m_9	1 m_{11}	0 m_{10}

$$\therefore F = B'D + BD' = B \oplus D$$

$$\textcircled{11} F = \sum (0, 2, 5, 9, 15) = \overline{A}\overline{B}\overline{C}D + \overline{A}B\overline{C}D + AB\overline{C}D + \overline{A}B\overline{D}$$

AB \ CD	00	01	11	10
00	1 m_0	0 m_1	0 m_3	1 m_2
01	0 m_4	1 m_5	0 m_7	0 m_6
11	0 m_{12}	0 m_{13}	1 m_{15}	0 m_{14}
10	0 m_8	1 m_9	0 m_{10}	0 m_{11}

$$\textcircled{12} F = \sum (1, 8, 9, 10)$$

AB \ CD	00	01	11	10
00	0 m_0	1 m_1	0 m_3	0 m_2
01	0 m_4	0 m_5	0 m_7	0 m_6
11	0 m_{12}	0 m_{13}	0 m_{15}	0 m_{14}
10	1 m_8	1 m_9	0 m_{11}	1 m_{10}

$$\therefore F = B'\overline{C}D + AB'D'$$

$$\textcircled{13} F(A, B, C, D) = \sum (4, 5, 6, 9, 13, 14)$$

AB \ CD	00	01	11	10
00	m_0	m_1	m_3	m_2
01	1 m_4	1 m_5	m_7	1 m_6
11	m_{12}	1 m_{13}	m_{15}	1 m_{14}
10	m_8	1 m_9	m_{11}	m_{10}

$$\therefore F = A\overline{B}\overline{C}D$$

④ Example of don't care:

$$F_2(A, B, C, D) = \sum (5, 6, 9, 13, 15) + d(1, 7, 14)$$

$$F_2(A, B, C, D) = \prod (0, 2, 3, 4, 8, 10, 11, 12) \cdot d(1, 7, 14)$$

Find out SOP and POS form?

SOP

AB \ CD	00	01	11	10
00	0 m ₀	X m ₁	0 m ₃	0 m ₂
01	0 m ₄	1 m ₅	X m ₇	1 m ₆
11	0 m ₁₂	1 m ₁₃	1 m ₁₅	X m ₁₄
10	0 m ₈	1 m ₉	0 m ₁₁	0 m ₁₀

$$\therefore F_{SOP} = BD + AC'D + A'BC$$

$$F_{POS} = (C+D) \cdot (B+C')$$

$$F_{POS} = (C+D) \cdot (B+C')$$

AB \ CD	00	01	11	10
00	0	X	0	0
01	0	1	X	1
11	0	1	1	X
10	0	1	0	0

⊕ Prime Implicant :- The largest group of 1s which can be circled to cover the particular 1 is called prime Implicant.
 বড়তম ১ এর গ্রুপ যাতে একটি prime implicant cover করতে পারে।

AB \ CD	00	01	11	10
00	0 m ₀	0 m ₁	0 m ₃	0 m ₂
01	1 m ₄	1 m ₅	1 m ₇	1 m ₆
11	0 m ₁₂	1 m ₁₃	1 m ₁₅	1 m ₁₄
10	0 m ₈	1 m ₉	0 m ₁₁	0 m ₁₀

∴ Prime implicant :-

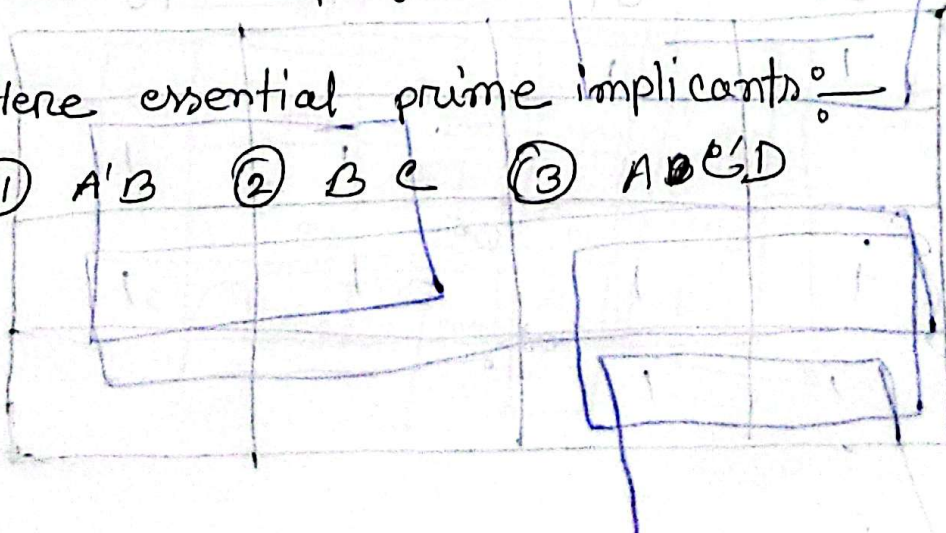
- ① $A'B$ ② BD ③ BC ④ $AC'D$

Essential Prime Implicant :- যার 1 সুরক্ষা single

১ এর গ্রুপ ২ essential prime implicant

Here essential prime implicants :-

- ① $A'B$ ② BC ③ $AC'D$



⑦ Finding Prime implicant and Essential Prime

AB \ CD	00	01	11	10
00	1 m_0	0 m_1	0 m_3	1 m_2
01	0 m_4	1 m_5	0 m_7	1 m_6
11	1 m_{12}	1 m_{13}	0 m_{15}	1 m_{14}
10	1 m_8	1 m_9	0 m_{11}	1 m_{10}

Here prime implicants are:

- ① $B'D'$ ② Ac' ③ $Bc'D$

Essential Prime implicant $\rightarrow$

- ① $B'D$ ② $Bc'D$ ③ Ac'

⑧ Find prime implicant and Essential prime implicant

AB \ CD	00	01	11	10
00	1			
01				
11	1	1		
10	1	1		

prime implicants:

- (i) $B'C'$ (ii) Ac' (iii) BC

Essential prime implicant:

- (i) $B'C'$ (ii) Ac' (iii) BC

For the following

Previous Year question Solve:

Spring-2024 Soln

(3) (i) Given function,

$$F(A, B, C, D) = \Pi_M(0, 1, 3, 7, 8, 9, 11) + \Sigma_D(12, 13, 14, 15)$$

$$= \Sigma_m(2, 4, 5, 6, 10) + \Sigma_d(12, 13, 14, 15)$$

AB \ CD	00		01		11		10	
	00	01	11	10	00	01	11	10
00	0 m_0	0 m_1	0 m_3	1 m_2	0 m_4	1 m_5	0 m_7	1 m_6
01	1 m_4	1 m_5	0 m_7	1 m_6	X m_{12}	X m_{13}	X m_{15}	X m_{14}
11	X m_{12}	X m_{13}	X m_{15}	X m_{14}	0 m_8	0 m_9	0 m_{11}	1 m_{10}
10	0 m_8	0 m_9	0 m_{11}	1 m_{10}				

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

Here,

Literals = 4

Number of terms = 2

complements = 2

$$\therefore \text{Total cost}_{SOP} = 4 + 2 + 2 = 8$$

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

Here, literals = 4

Number of terms = 2

Distinct complements = 2

$$\therefore \text{Total cost}_{POS} = 4 + 2 + 2 = 8$$

iii) Here,

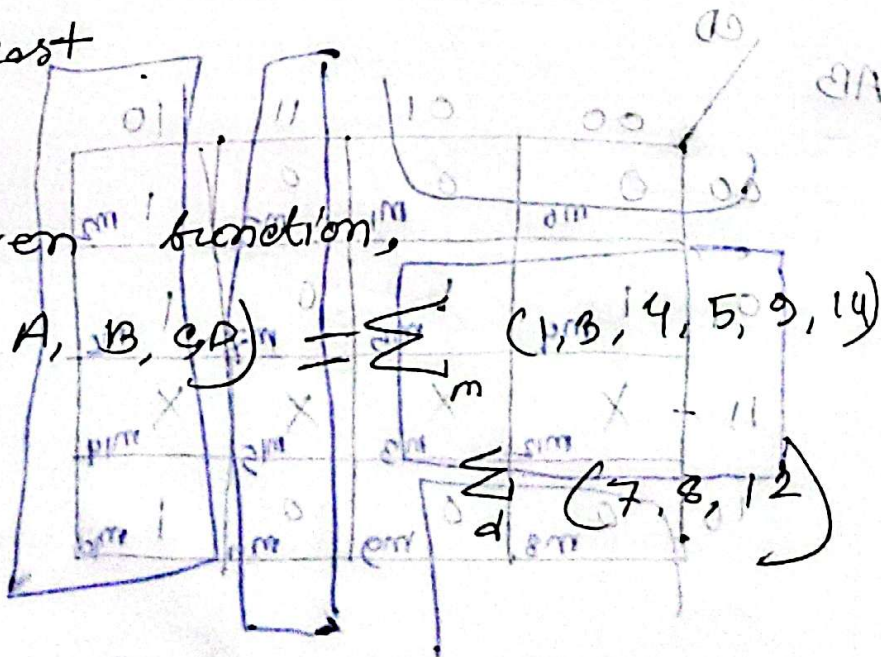
$G_{SOP} \neq G_{POS}$ So both are

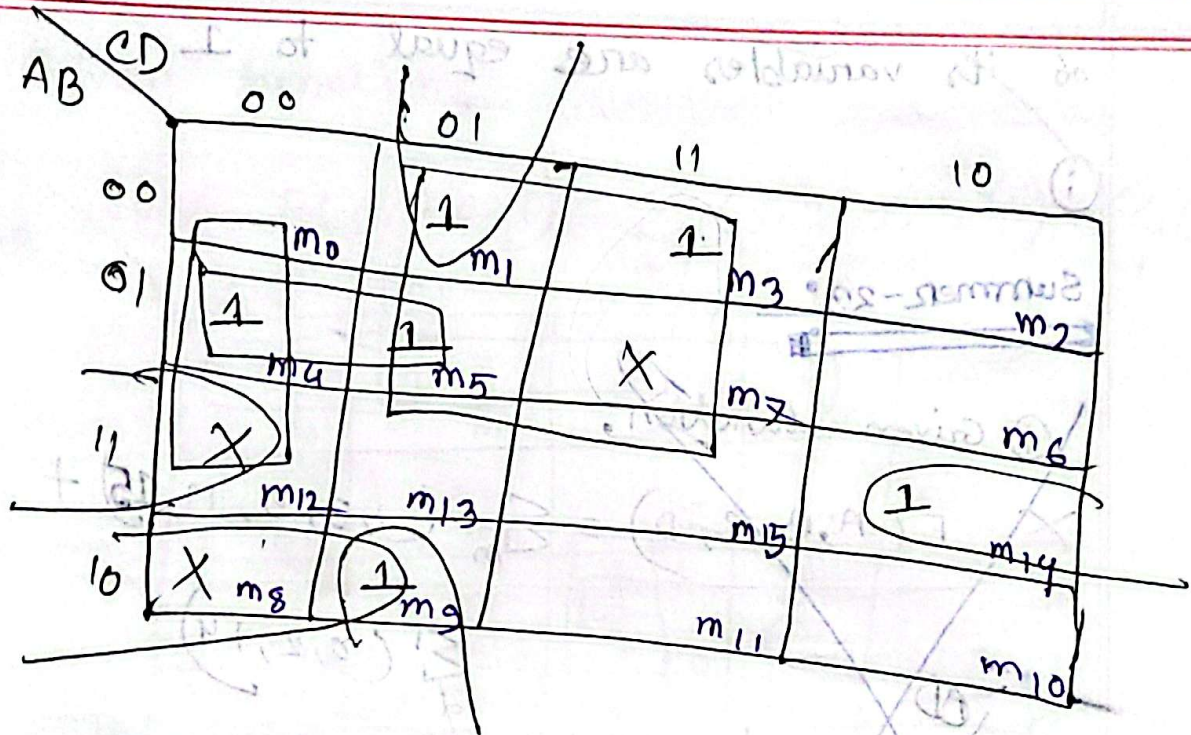
same cost

2

i) Given function,

$$F(A, B, C, D) = \sum_m (1, 3, 4, 5, 9, 14) + \sum_d (7, 8, 12)$$





①. Prime implicants:

- ① $A'D$ ② ABC' ③ $B'C'D$ ④ ABD'
 ⑤ $AB'C'$ ⑥ $BC'D'$

ii) Essential prime implicant:

- ① $A'D$ ② $AB\bar{D}$

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

Spring-2024

Given function that,

A three variable truth table that is equal to 1 if any two or all three.

(i) Given function,

$$F(A, B, C, D) = \sum (1, 3, 9, 11, 15) + \sum_d (0, 2, 4)$$

AB \ CD	00	01	11	10
00	X	1	1	X
01				
11			1	X
10		1	1	

Map 1: Karnaugh map for the given function. The map shows 1s at minterms 1, 3, 9, 11, and 15, and Xs at minterms 0, 2, and 4. The prime implicants are circled and numbered 1 through 4.

prime implicants: ① $\bar{B}D$ ② $\bar{A}\bar{B}$ ③ $AB\bar{C}$

④ $ABCD$

Essential prime implicant: ① $\bar{B}D$ ② $\bar{A}\bar{B}$

③ $AB\bar{C}$ ④ $ABCD$

(iii) Applying selection Rule:

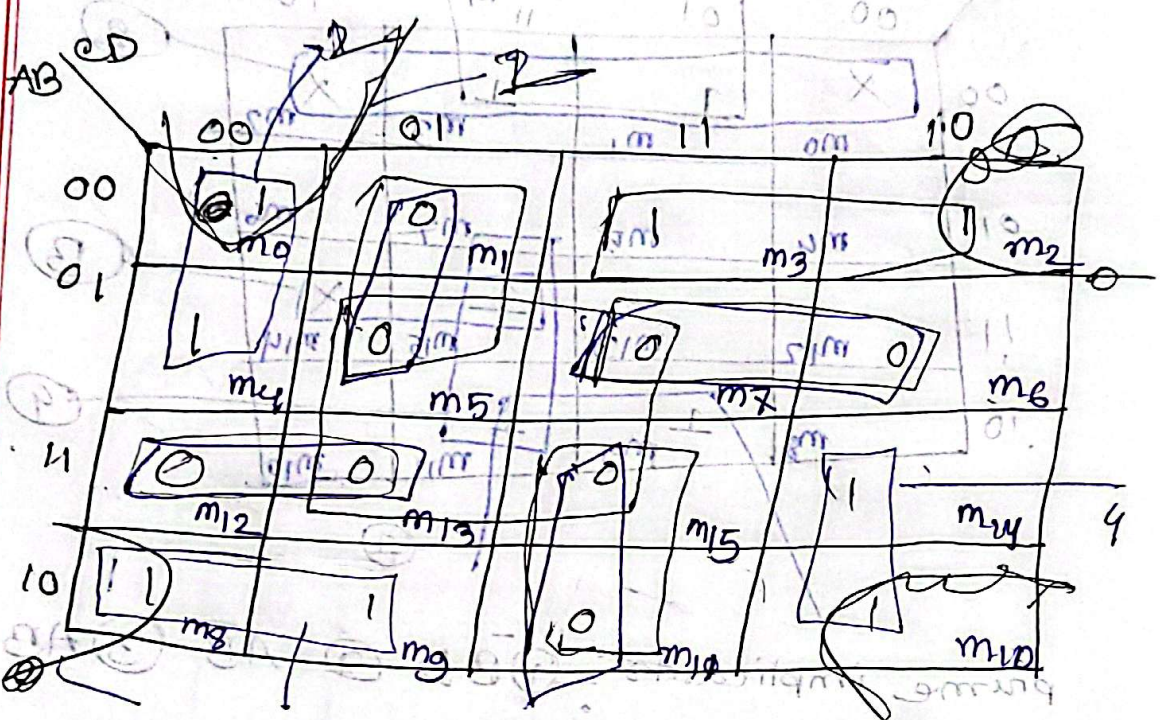
AB \ CD	00	01	11	10
00	X	1	1	X
01	0	0	0	0
11	0	0	1	X
10	0	1	1	0

Map 2: Karnaugh map showing the selection of prime implicants. The map shows 1s at minterms 1, 3, 9, 11, and 15, and Xs at minterms 0, 2, and 4. The prime implicants are circled and numbered 1 through 4.

$$F = \bar{B}D + AB\bar{C}$$

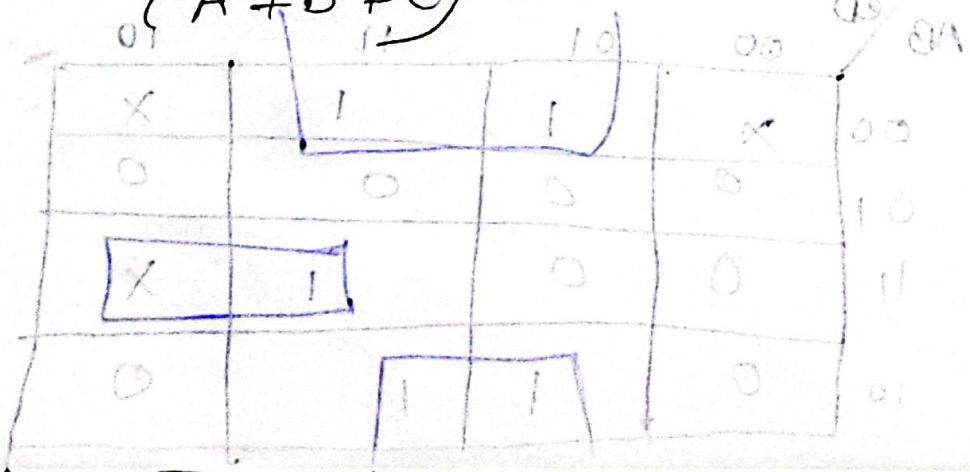
② Given function, (1)

$$F(A, B, C, D) = \sum m(0, 2, 3, 4, 8, 9, 10, 14)$$



$$\therefore F_{SPO} = \overline{A} \overline{C} \overline{D} + AB' \overline{C} + A \overline{C} \overline{D} + \overline{A} \overline{B} \overline{C}$$

$$(ii) F_{POS} = (\overline{A} + \overline{B} + \overline{C}) \cdot (A + C + D) \cdot (A + B' + \overline{C})$$



(iii) Here, For F_{SOP} Gate cost,

$$G_{F_{SOP}} = 12 + 4 + 4 = 20$$

$$G_{F_{POS}} = 12 + 4 + 4 = 20$$

$\therefore G_{SOP} = G_{POS}$ So, Implementing both minimized SOP and POS are same.

(5) Given function,

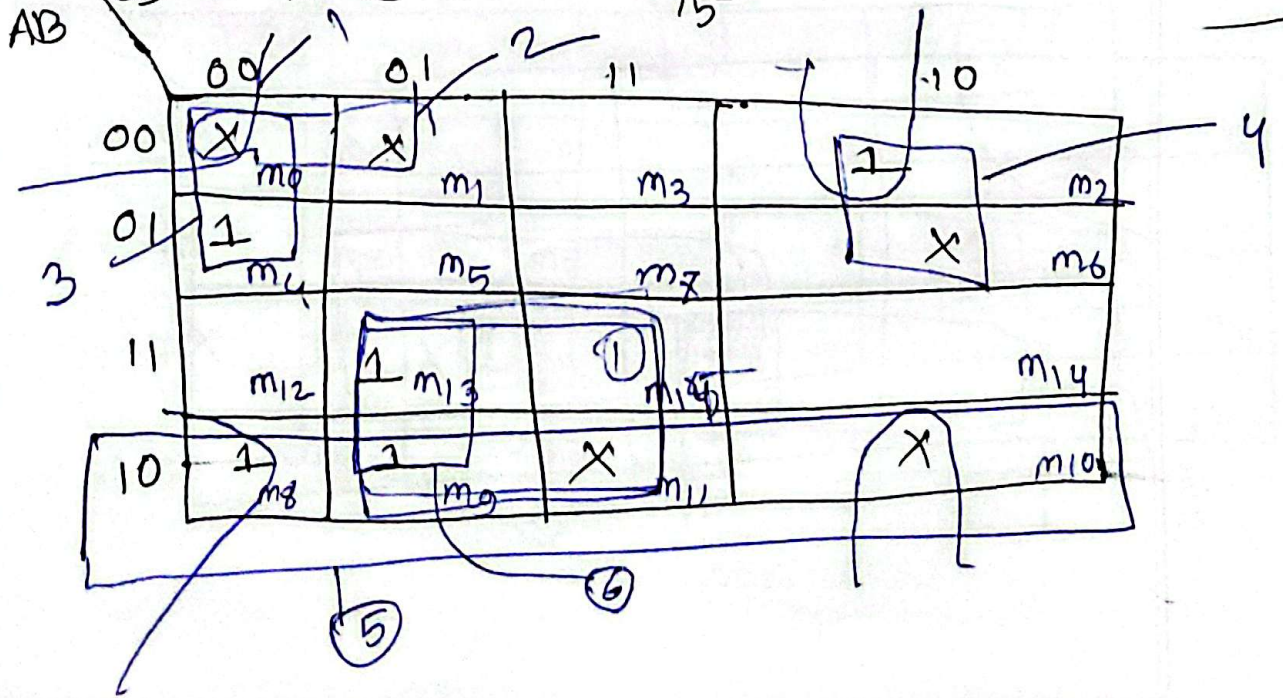
$$F(A, B, C) =$$

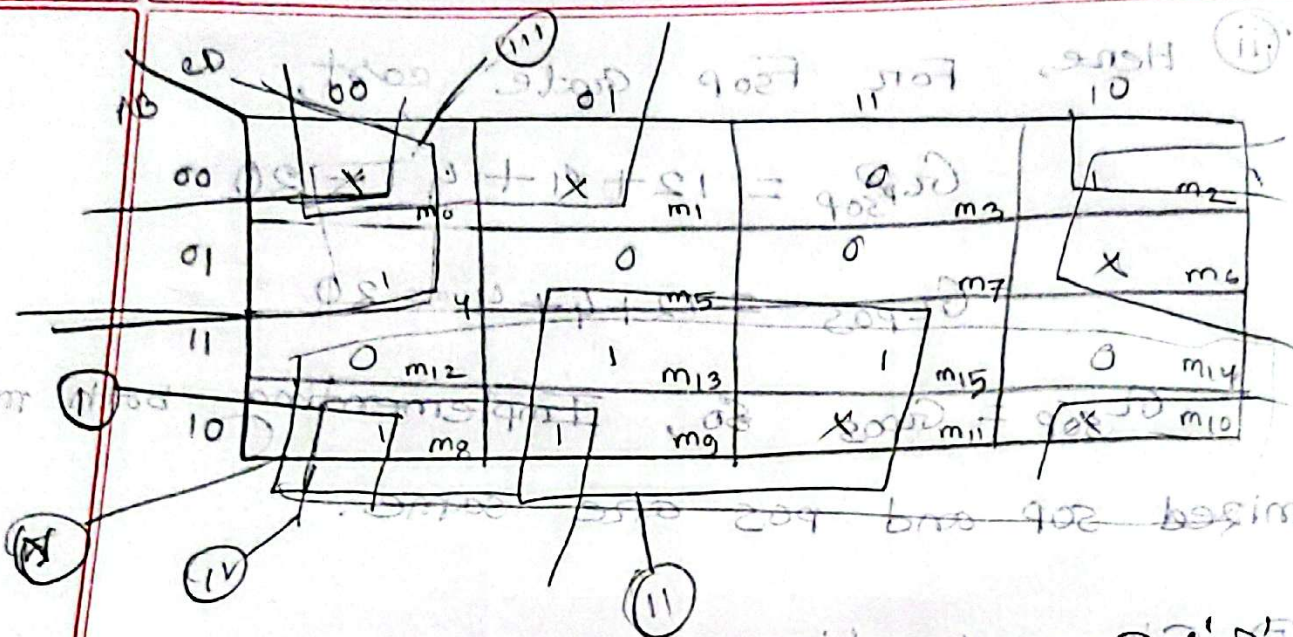
⊕ Fall-23

(3i) Given function,

$$F(A, B, C, D) = \Pi_M(3, 5, 7, 12, 14) + \Sigma_d(0, 1, 6, 10, 11)$$

$$= \Sigma_m(2, 4, 8, 9, 13, 15) + \Sigma_d(0, 1, 6, 10, 11)$$

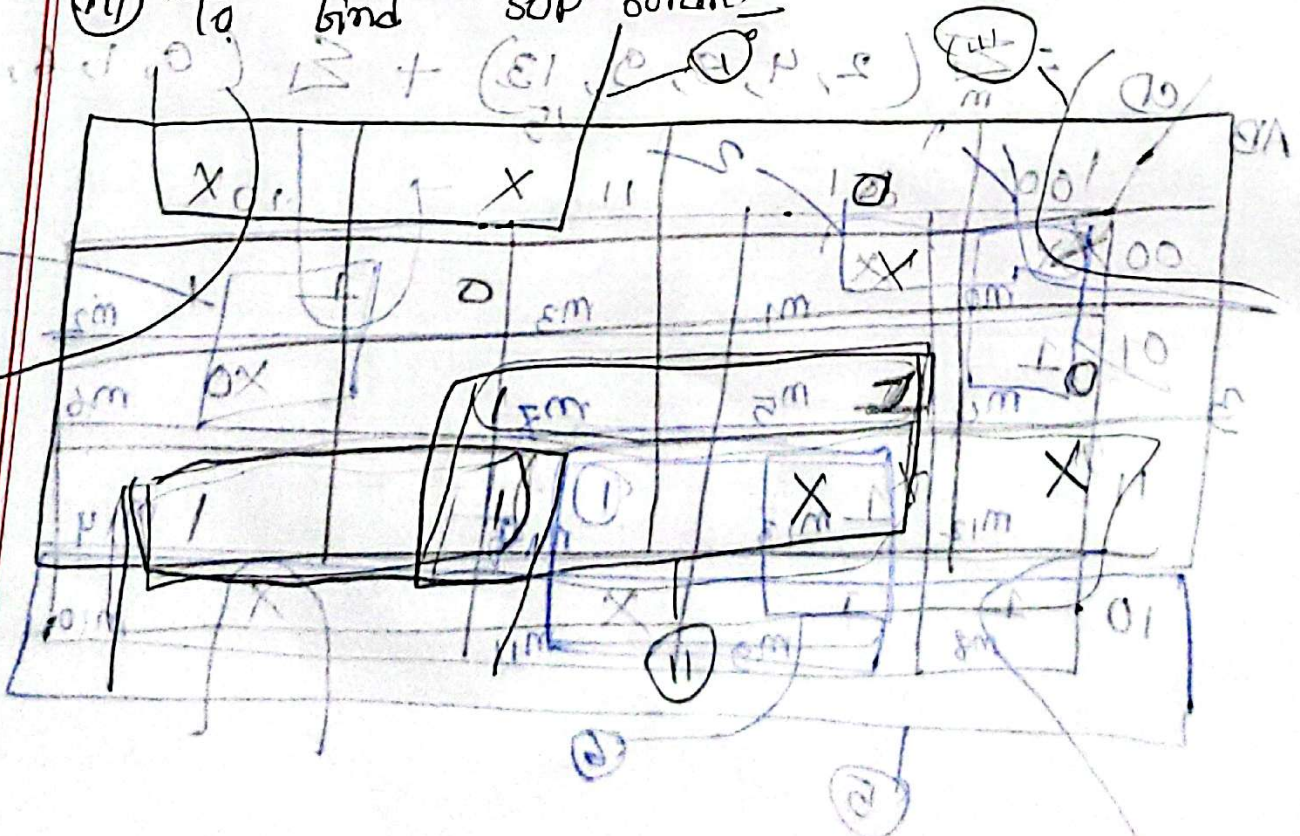




∴ Prime implicant :- (i) $B'D'$ (ii) AD (iii) $A'D$ (iv) $B'C'$ (v) AB'

(i) Essential prime implicant :- $A'D$ (ii) AD

(iv) To find SOP form



$$F = B'C' + AD + \bar{A}\bar{D}$$

(4)

Give that, $(2+0+9)(9+9) = 209$

$$F(P, Q, R, S) = \bar{P}\bar{Q}R + \bar{P}'QRS' + PQR'S + PQR$$

$$= \bar{P}\bar{Q}R(S+\bar{S}) + \bar{P}'QRS' + PQR'S + PQR(S+\bar{S})$$

$$= \bar{P}\bar{Q}'RS + \bar{P}\bar{Q}RS' + \bar{P}'QRS' + PQR'S + PQRSt$$

$$= \bar{P}\bar{Q}'RS + \bar{P}\bar{Q}RS' + \bar{P}'QRS' + PQR'S + PQRSt$$

$$= \bar{P}\bar{Q}'RS + \bar{P}\bar{Q}'RS' + \bar{P}'QRS' + PQR'S + PQRSt$$

$$= \bar{P}\bar{Q}'RS + \bar{P}\bar{Q}'RS' + \bar{P}'QRS' + PQR'S + PQRSt$$

$$= \sum_m (m_2, m_3, m_{10}, m_{11}, m_6, m_{13}, m_{14}, m_{15})$$

$$= \prod M (M_0, M_1, M_2, M_3, M_4, M_5, M_7, M_8, M_9, M_{12})$$

RS	R'S'	R'S	RS	RS'
PQ	00	01	11	10
P'Q'00	0 m ₀	0 m ₁	0 m ₂	0 m ₃
P'Q'01	0 m ₄	0 m ₅	0 m ₆	1 m ₇
PQ'11	0 m ₁₂	1 m ₁₃	1 m ₁₅	1 m ₁₄
PQ'10	0 m ₈	0 m ₉	1 m ₁₁	1 m ₁₀

$$X = 0111$$

$$X = 1111$$

$$\therefore F_{SOP} = PR + PQS + QRS$$

$$\therefore F_{POS} = (P+R') (P'+Q'+S') (Q'+R'+S')$$

$$\therefore F_{POS} = (R+S) (P+Q) (Q+R) (P+S)$$

8 April
2025

1st Sat - 0000

1st Sun - 0001

2nd Mon - 0010

Tue - 0011

Wed - 0100

Thurs - 0101

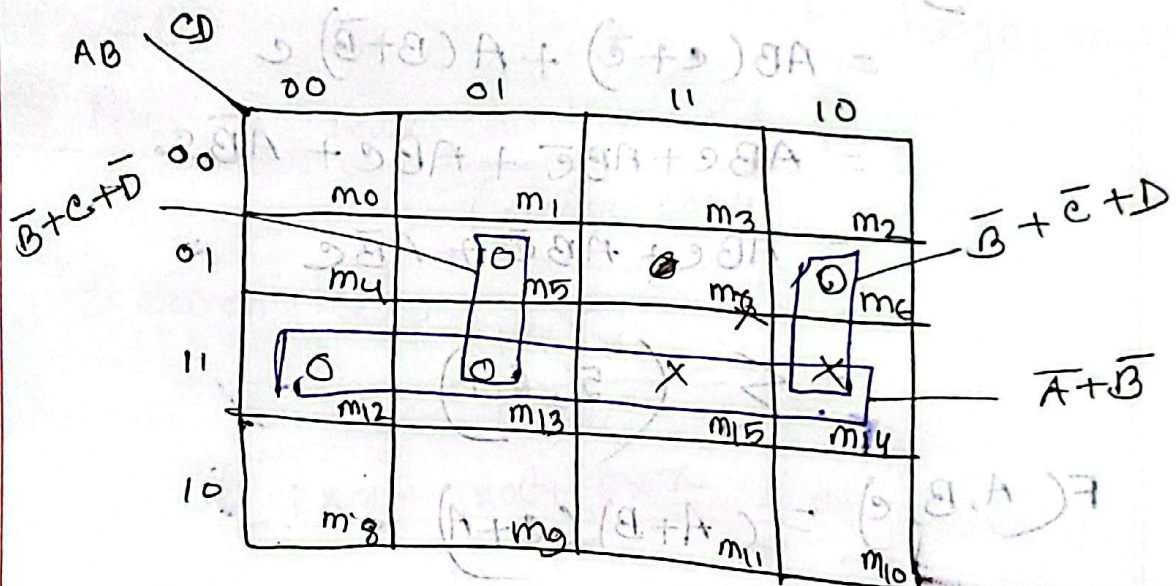
1st Fri

2nd Sat -

2nd Fri -

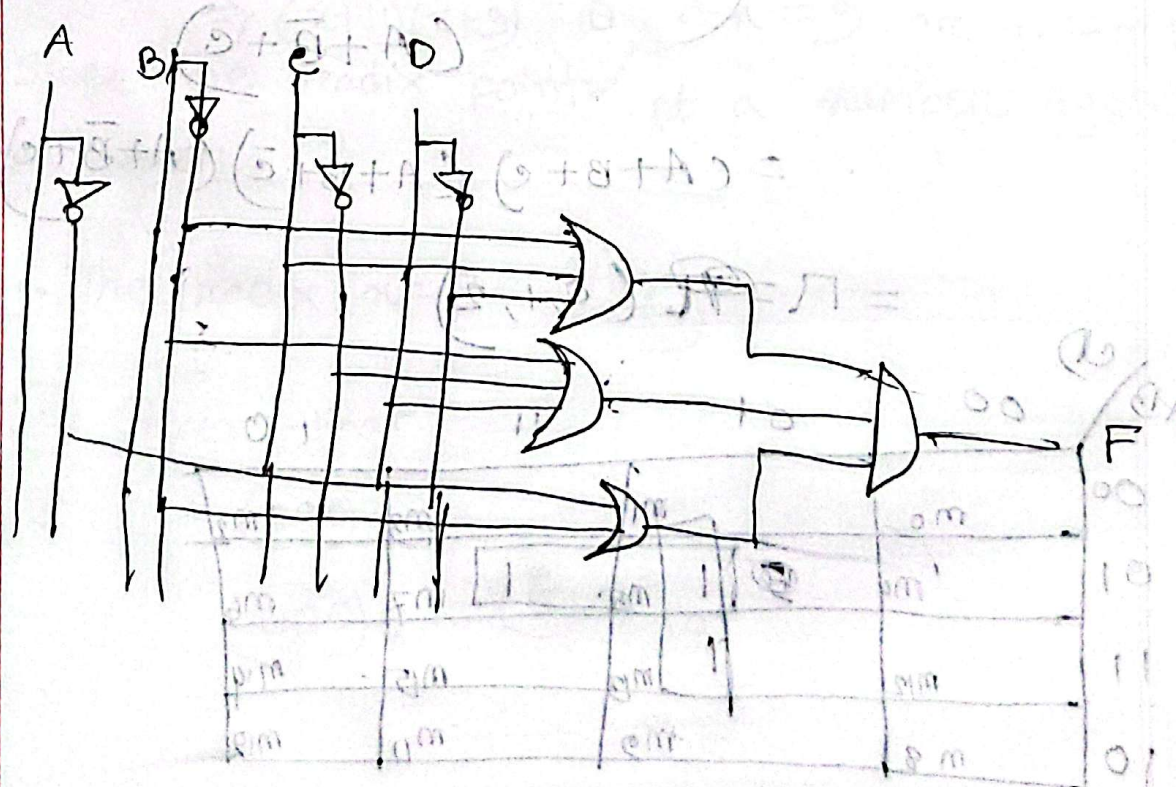
1110 - X

1111 - X



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

∴ logic diagram



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

$$F(A, B, C) = AB + AC$$

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

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

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

$$= \sum (5, 6, 7)$$

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

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

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

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

$$= \prod (0, 1, 2)$$

AB \ C	00	01	11	10
00	m ₀	m ₁	m ₂	m ₃
01	m ₄	m ₅	m ₆	m ₇
11	m ₈	m ₉	m ₁₀	m ₁₁
10	m ₁₂	m ₁₃	m ₁₄	m ₁₅

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

$Y = 4 \text{ literal less than } X$ [যেকোনো ৪কটা literal
 $= BD$ change করতে পারবে]

⊕ Previous Year Question Solve:

spring-2024

① a Given that, $\frac{(126)_x}{(5)_x} = 21$

$$\Rightarrow \frac{1 \times x^2 + 2 \times x^1 + 6 \times x^0}{5 \times x^0} = 21$$

$$\Rightarrow x^2 + 2x + 6 = 105 \Rightarrow x^2 + 2x - 99 = 0$$

$$\Rightarrow x^2 + 11x - 9x - 99 = 0 \Rightarrow x(x+11) - 9(x+11) = 0$$

$$\Rightarrow (x+11)(x-9) = 0 \therefore x = 9 \text{ or } x = -11$$

Since the radix point of a number system cannot be negative.

$\therefore$ The radix, $x = 9$. (Ans.)

ⓑ Given that,

$$(690)_{10}$$

$$(1000)_8 = (512)_{10}$$

8 4 2 1

Date:

Now, $(690)_{10} = (01101001)_{2}$

$(512)_{10} = (01010001100)_{2}$

10111010010
110 110

1001001000000010

$0001 \rightarrow 00010 \rightarrow 0000 \rightarrow 0010$
 $\downarrow \quad \downarrow \quad \downarrow \quad \downarrow$
 $1 \quad 2 \quad 0 \quad 2$

$(1202)_{BCD}$

$\therefore (690)_{10} + (512)_{10} = (1202)_{10}$

$(1202)_{BCD} + (512)_{10} = (1202)_{10}$

⑦ Given that,

$\times F(A, B, C, D) = AB + BD + BCD + ACD$

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

$ACD(B + \bar{B})$

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

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

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

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

8421 29871

Date:

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

$$= m_5 + m_8 + m_9 + m_7 + m_6 + m_4 + m_7 :$$

(A) Given that,

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

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

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

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

$$+ \overline{A'B\bar{C}D'} + \overline{A'B\bar{C}'D'} + \overline{AB\bar{C}D} + \overline{AB\bar{C}'D} + \overline{AB\bar{C}D}$$

$$+ AB\bar{C}'D'$$

$$= \cancel{m_6 + m_5} + \cancel{m_4 + m_3} + \cancel{m_8 + m_7} + m_7 + m_1 +$$

$$= m_7 + m_6 + m_5 + m_4 + m_{14} + m_{12} + m_9 + m_{11} +$$

$$= \sum m \left(\overset{m_{10}}{1, 4, 5, 6, 7, 9, 10, 12, 14} \right)$$

$$= \pi_m \left(\overset{13}{0, 2, 3, 8, 11, 15} \right)$$

$$\therefore \text{Sum of minterms} = \sum_m (1, 4, 5, 6, 7, 9, 10, 12, 14)$$

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

$$+ \overline{A'B\bar{C}'D} + \overline{AB\bar{C}D'} + \overline{AB\bar{C}'D} + \overline{AB\bar{C}D}$$

$$\therefore \text{Product of Maxterms} = \pi_m (0, 2, 3, 8, 11, 13, 15)$$

Date: / /

$$\begin{aligned}
 \textcircled{2} \quad F(A, B, C, D) &= (AB + C)(AB + D) + (C + D)(A + B + BD') \\
 &= \overline{AB} + \overline{ABD'} + \overline{AB}C' + \overline{C'D'} + \overline{AC} + \overline{BC} + \overline{AD} + \overline{BD} + \overline{BD'} \\
 &= A(B + \overline{BD'} + \overline{BC'} + \overline{C + D}) + B(C + D + D') + C'D' \\
 &= A(B + C + D) + B(C + D) + C'D' \\
 &= \overline{AB} + \overline{AC} + \overline{AD} + \overline{B} + \overline{C'D'} \quad \boxed{F = \overline{B} + \overline{A} + \overline{C} + \overline{A}C'D + \overline{A}C'D + \overline{A}C'D'} \\
 &\quad + C'D'
 \end{aligned}$$

$$\begin{aligned}
 \textcircled{3} \quad \boxed{B + A} &= B + AB + AC + AC'D + AC'D + C'D' \\
 &= B + AC(1 + D) + C'(D' + DA) = B + AC + C'(D + A) \\
 &= B + AC + C'D + AC' = B + A(C + C') + C'D' = B + A + C'D' \\
 &\quad \text{(Ans)}
 \end{aligned}$$

③ Given function, $F(A, B, C, D) = \sum_m (0, 1, 3, 7, 8, 9, 11, 15)$

$$\sum_d (12, 13, 14, 15)$$

AB \ CD	00	01	11	10
00	0	0	0	1
01	1	1	0	1
11	1	1	1	1
10	0	0	0	1

$$\therefore F_{\text{Sop}} = \overline{C}D + \overline{B}C'$$

$$F_{\text{Sop}} = \overline{C}D + \overline{B}C'$$

$$= \overline{B}C' + \overline{C}D$$

Date: / /

ii) Essential Prime Implicant :-

i) $A'D$ ii) ABD'

iii) Applying Selection Rule :-

AB \ CD	00	01	11	10
00	0 m_0	1 m_1	1 m_3	0 m_2
01	1 m_4	1 m_5	X m_7	0 m_6
11	X m_{12}	0 m_{13}	0 m_{15}	1 m_{14}
10	X m_8	1 m_9	0 m_{11}	0 m_{10}

$$\therefore F = A'D + B'C'D' + AB'D' + ABD'$$

Ans - to the - Q No - 05

i) The truth table drawn below :-

A	B	C	F
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

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Ans - to the Q - No - 06

• 4bit

(a) Show the truth table given below:-

	A	B	C	D	F
m ₀	0	0	0	0	X
m ₁	0	0	0	1	0
m ₂	0	0	1	0	0
m ₃	0	0	1	1	1
m ₄	0	1	0	0	0
m ₅	0	1	0	1	0
m ₆	0	1	1	0	1
m ₇	0	1	1	1	0
m ₈	1	0	0	0	0
m ₉	1	0	0	1	1
m ₁₀	1	0	1	0	0
m ₁₁	1	0	1	1	0
m ₁₂	1	1	0	0	1
m ₁₃	1	1	0	1	X
m ₁₄	1	1	1	0	X
m ₁₅	1	1	1	1	X

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Ans-to-the-Q-No-02

Here,

$$(A55)_{16} = 10 \times 16^2 + 5 \times 16^1 + 5 \times 16^0$$

$$= 2560 + 80 + 5$$

$$= (2645)_{10}$$

$$\therefore (2645)_{10}$$

$$(8764)_9 = 8 \times 9^3 + 7 \times 9^2 + 6 \times 9^1 + 4 \times 9^0$$

$$= 5832 + 567 + 54 + 4$$

$$= (6457)_{10}$$

$$(2645)_{10} = (0010 \ 0110 \ 0100 \ 0101)_{BCD}$$

$$(6457)_{10} = (0110 \ 0100 \ 0101 \ 0111)_{BCD}$$

(+)

$$1000 \ 1010 \ 1001 \ 1100$$

$$110$$

$$110$$

$$1001 \ 1100 \ 0000 \ 1010 \ 10010$$

$$110$$

$$1001 \ 0001 \ 0000 \ 0010$$

$$9$$

$$1$$

$$0$$

$$2$$

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$$\therefore (2645)_{10} + (6457)_{10} = (9102)_{10} \quad (\text{Ans})$$

$$\text{Ans} \rightarrow 10 - 11e - 9 - \sqrt{6} - 03$$

Here, $(q + r' + q'r') (qr + pr' + pr)$

$$= q \cdot qr + pr'q + prqr + qr \cdot r' + pr'pr + q'r'qr + q'r'pr' + q'r'pr$$

$$= qr + 0 + prqr + 0 + pr'r' + 0 + 0 + 0 + 0$$

$$+ 0 \quad [a \cdot \bar{a} = 0]$$

$$= qr + prqr + pr'r'$$

$$= qr(1+p) + pr'r' \quad (\text{Ans})$$

$$= qr + pr'r' \quad (\text{Ans})$$

$$\text{Ans} \rightarrow 10 - 11e - 9 - \sqrt{6} - 9$$

Here, $(x'y' + z') + z + xy + wz$

$$= (x'y') \cdot z' + z' + z + xy + wz$$

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

$$= xz' + yz' + z' + z + xy + wz$$

$$= \cancel{xz' + yz'} + z'(1+w) + xy$$

$$\cancel{xz' + yz'}$$

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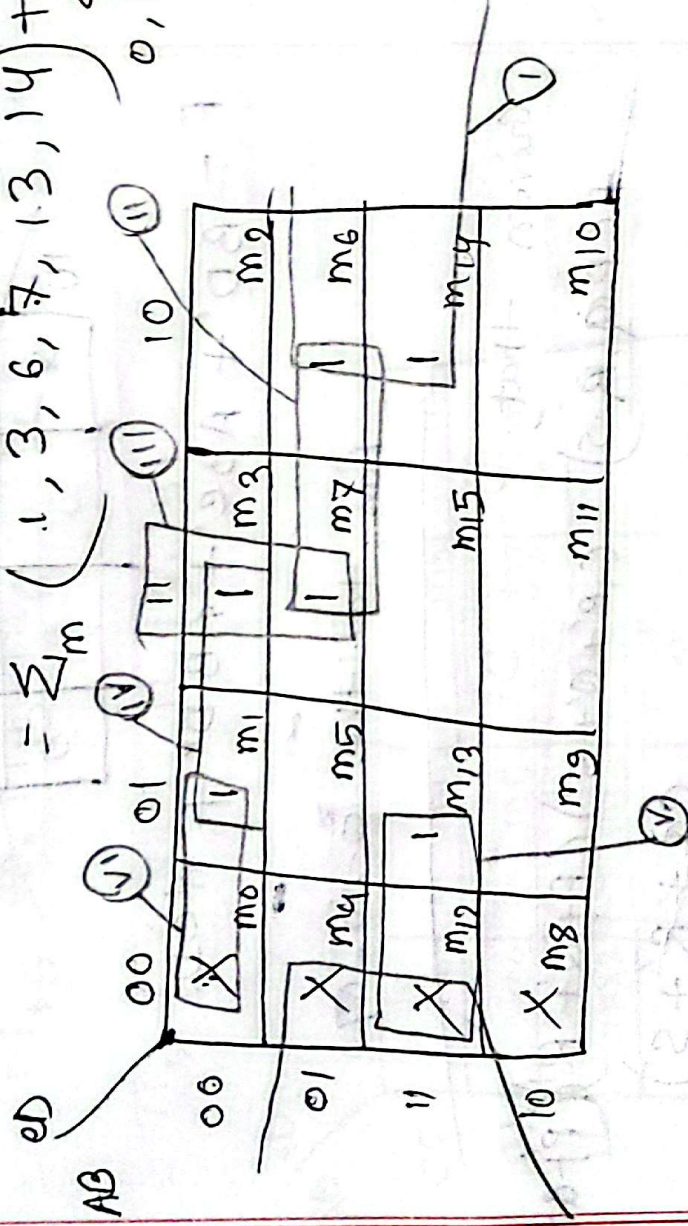
Ans-10-the- Q- No- 05

(a) Given that,

$$F(A, B, C, D) = \pi_m(2, 5, 9, 10, 11, 15) +$$

$$\sum_d(0, 4, 8, 12)$$

$$= \sum_m(1, 3, 6, 7, 13, 14) + \sum_d(0, 4, 8, 12)$$

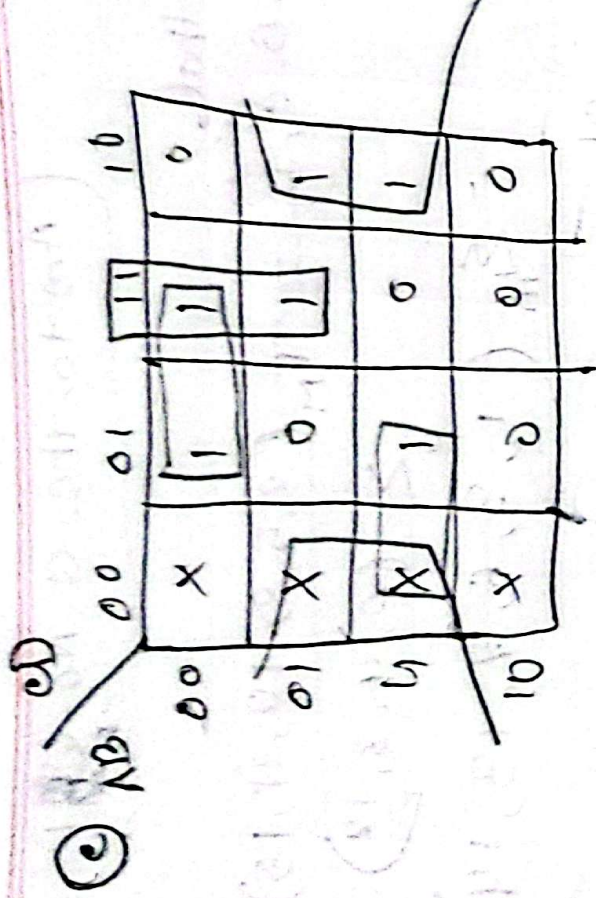


prime implicant :- (i) BD' (ii) $A'B$ (iii) $A'E$ (iv) $A'B'D$

(v) ABE' (vi) $A'B'C$

(vii) Essential prime implicant :-

(i) BD' (v) ABE'



$$F = BD' + AB'E' + AB'D' + A'ED$$

Ans - to - the - Q - No - 07

Given that,

$$F(P, Q, R, S) = (C'P' + Q' + S')(P + Q' + R')(P + Q + S')$$

$$CQ + R' + S'$$

$$= (P' + Q' + R' + S')(P + Q' + R' + S' + S')$$

$$(P' + Q + R \cdot R' + S')(P + Q' + R' + S')$$

$$= (P' + Q' + R + S')(P + Q' + R' + S')(P + Q + R' + S')$$

$$(P + Q' + R' + S')(P + Q + R + S')(P + Q + R' + S')$$

$$(P + R' + S')(P + Q' + R' + S)(P + Q' + R' + S')$$

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$$= (P' + Q' + R + S') (P' + Q' + R' + S') (P' + Q' + R' + S')$$

$$(P' + Q' + R' + S') (P' + Q + R + S') (P' + Q + R' + S')$$

$$= M_{13} \cdot M_{15} \cdot M_6 \cdot M_7 \cdot M_9 \cdot M_{11}$$

$$= \pi_M (6, 7, 9, 11, 13, 15)$$

	00	01	11	-10
00	m0	m1	m3	m2
01	m4	m5	m7	m6
11	m12	m13	m15	m14
10	m8	m9	m11	m10

$$\therefore F_{POS} = (A' + D') \cdot (A + B' + C') \quad (Ans)$$

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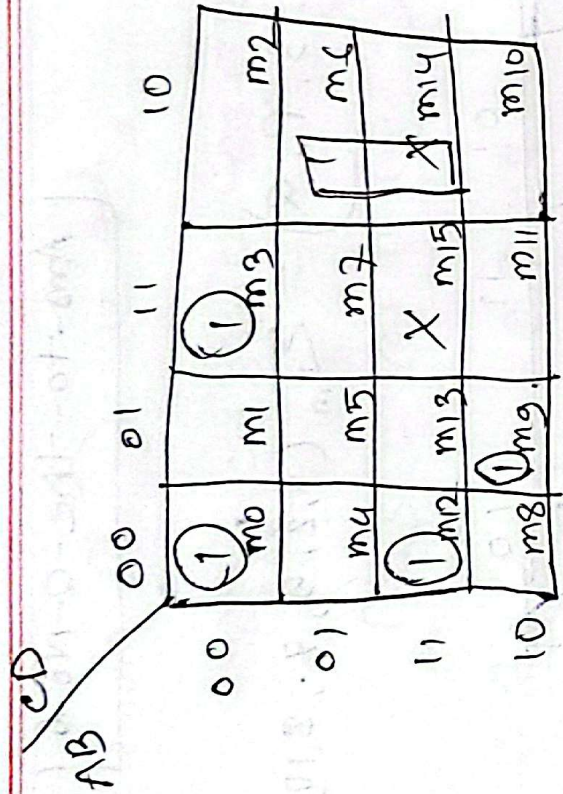
Ans-to-the-Q-No-08

(i)

	A	B	C	D	F
m0	0	0	0	0	1
m1	0	0	0	1	0
m2	0	0	0	0	0
m3	0	0	1	1	1
m4	0	1	0	0	0
m5	0	1	0	1	0
m6	0	1	1	0	1
m7	0	1	1	1	0
m8	1	0	0	0	0
m9	1	0	0	1	1
m10	1	0	1	0	0
m11	1	0	1	1	0
m12	1	1	0	0	1
m13	1	1	0	1	0
m14	1	1	1	0	x
m15	1	1	1	1	x

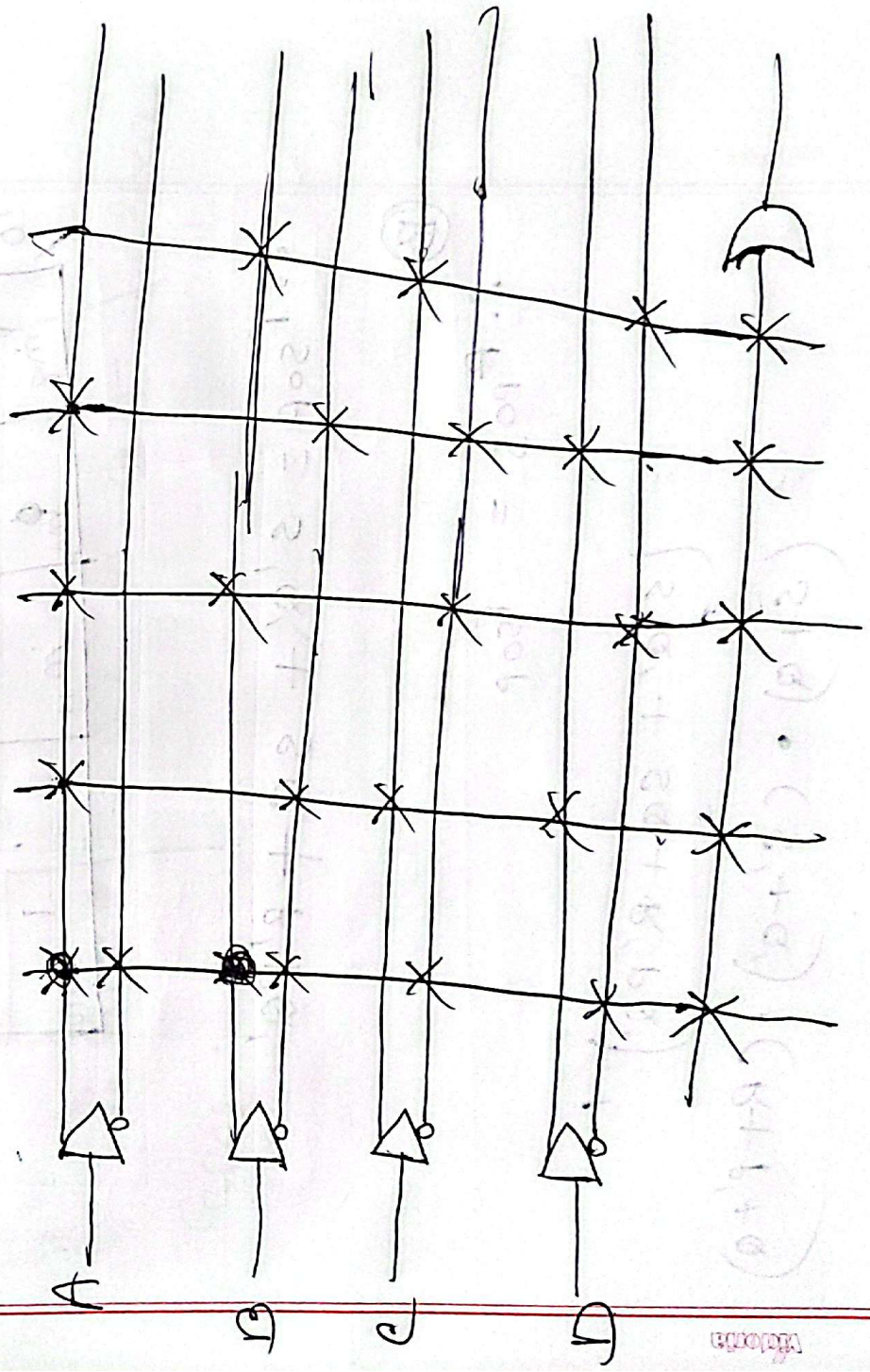
ii) Now, $\sum_m (m_0, m_3, m_6, m_9, m_{12}) + \sum_d (m_{14}, m_{15})$

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$$\therefore F_{SOP} = A'B'C'D' + A'B'CD + A'BC'D' + A'BCD + AB'C'D' + AB'CD + ABC'D' + ABCD$$

$$AB'C'D' + B'CD'$$



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② From ①, ③ we get,

$$r_{sop} = 3 \cdot a' + 5a + r'p'a'$$

$$f_{pos} = (3+a) \cdot (5+a) + (r+p'+a)$$

$$\therefore G_{sop} = 3 + 5 + 7 + 4$$

$$= 14$$

$$G_{pos} = 3 + 7 + 4 + 3$$

$$= 13$$

$\therefore G_{pos} < G_{sop}$, so G_I prefer G_{pos} .