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Assignment – 4

problem – 2.28

Soln:

Truth Table

x_1	x_2	x_3	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

$$f(x_1, x_2, x_3) = \sum m(3,5,6,7) = m_3 + m_5 + m_6 + m_7$$

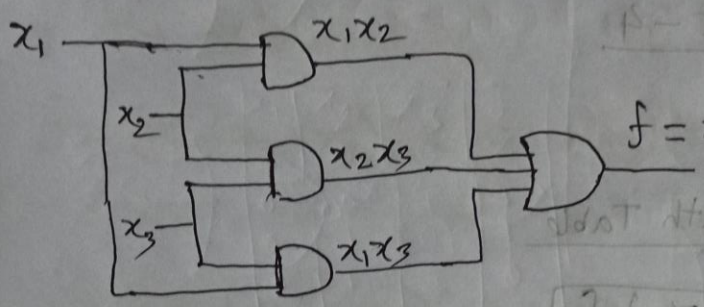
$$\Rightarrow f = \bar{x}_1 x_2 x_3 + x_1 \bar{x}_2 x_3 + x_1 x_2 \bar{x}_3 + x_1 x_2 x_3$$

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

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

(1) (2)

$\Rightarrow f = x_2x_3 + x_1x_3 + x_1x_2$



$\therefore f = x_2x_3 + x_1x_3 + x_1x_2$

Problem - 2.35

Soln: a) Truth Table

X		Y		Decimal numbers		Output
x_1	x_0	y_1	y_0	$X = x_1x_0$	$Y = y_1y_0$	$f(x_1, x_0, y_1, y_0$
0	0	0	0	0	0	1
0	0	0	1	0	1	0
0	0	1	0	0	2	0
0	0	1	1	0	3	0
0	1	0	0	1	0	0
0	1	0	1	1	1	1
0	1	1	0	1	2	0
0	1	1	1	1	3	0
1	0	0	0	2	0	0
1	0	0	1	2	1	0
1	0	1	0	2	2	1
1	0	1	1	2	3	0
1	1	0	0	3	0	0
1	1	0	1	3	1	0
1	1	1	0	3	2	0
1	1	1	1	3	3	1

b) From the truth table, only the input 0000, 0101, 1010, 1111 will give the output 1. Rest all combinations will give the output 0.

For product of sums expression, draw the karnaugh map and encircle all the essential 0s.

Determine the simplest possible product-of-sums expression for the output using k-map.

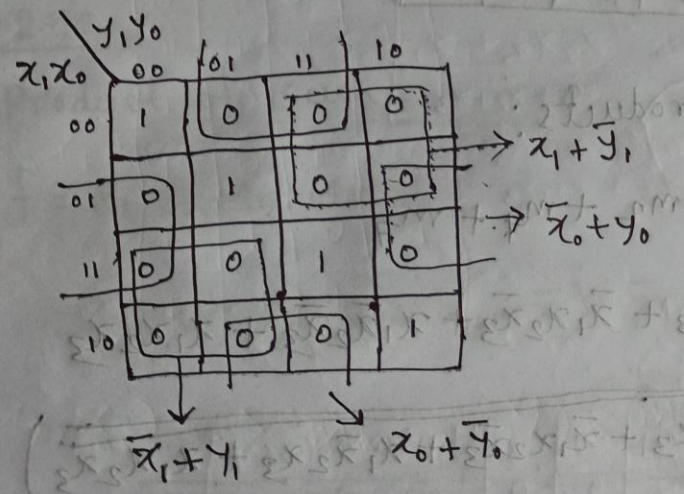


Fig: 1

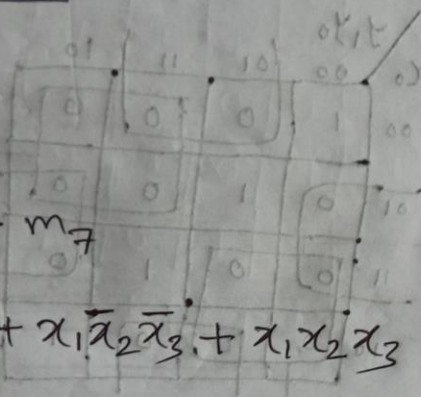
From Figure-1, the product of the sum expression is

$$f(x_1, x_0, y_1, y_0) = (\bar{x}_1 + y_1)(x_1 + \bar{y}_1)(\bar{x}_0 + y_0)(x_0 + \bar{y}_0).$$

Problem - 2.51

Soln: Figure 2.31 is given below.

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



Sum of products:

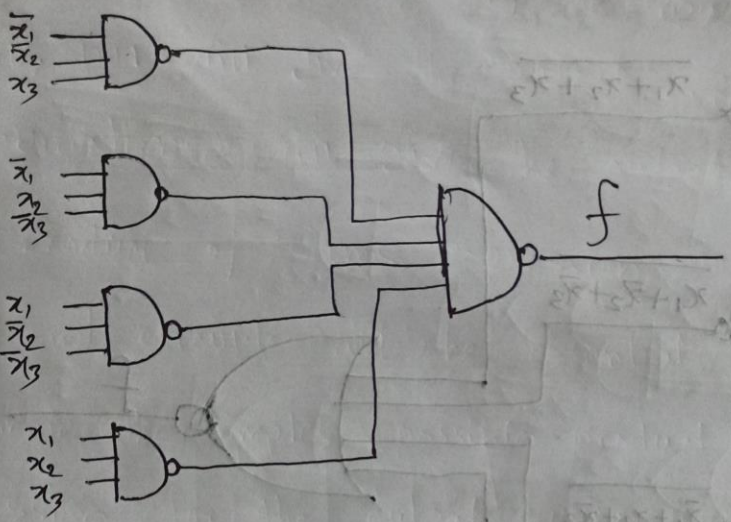
$$f = m_1 + m_2 + m_4 + m_7$$

$$\Rightarrow f = \bar{x}_1\bar{x}_2x_3 + \bar{x}_1x_2\bar{x}_3 + x_1\bar{x}_2\bar{x}_3 + x_1x_2x_3$$

$$\Rightarrow f = \overline{\left(\overline{\bar{x}_1\bar{x}_2x_3 + \bar{x}_1x_2\bar{x}_3 + x_1\bar{x}_2\bar{x}_3 + x_1x_2x_3}\right)}$$

$$\Rightarrow f = \left(\overline{\overline{\bar{x}_1\bar{x}_2x_3} \cdot \overline{\bar{x}_1x_2\bar{x}_3} \cdot \overline{x_1\bar{x}_2\bar{x}_3} \cdot \overline{\overline{x_1x_2x_3}}}\right)$$

[using de morgans law]



Problem-2.52

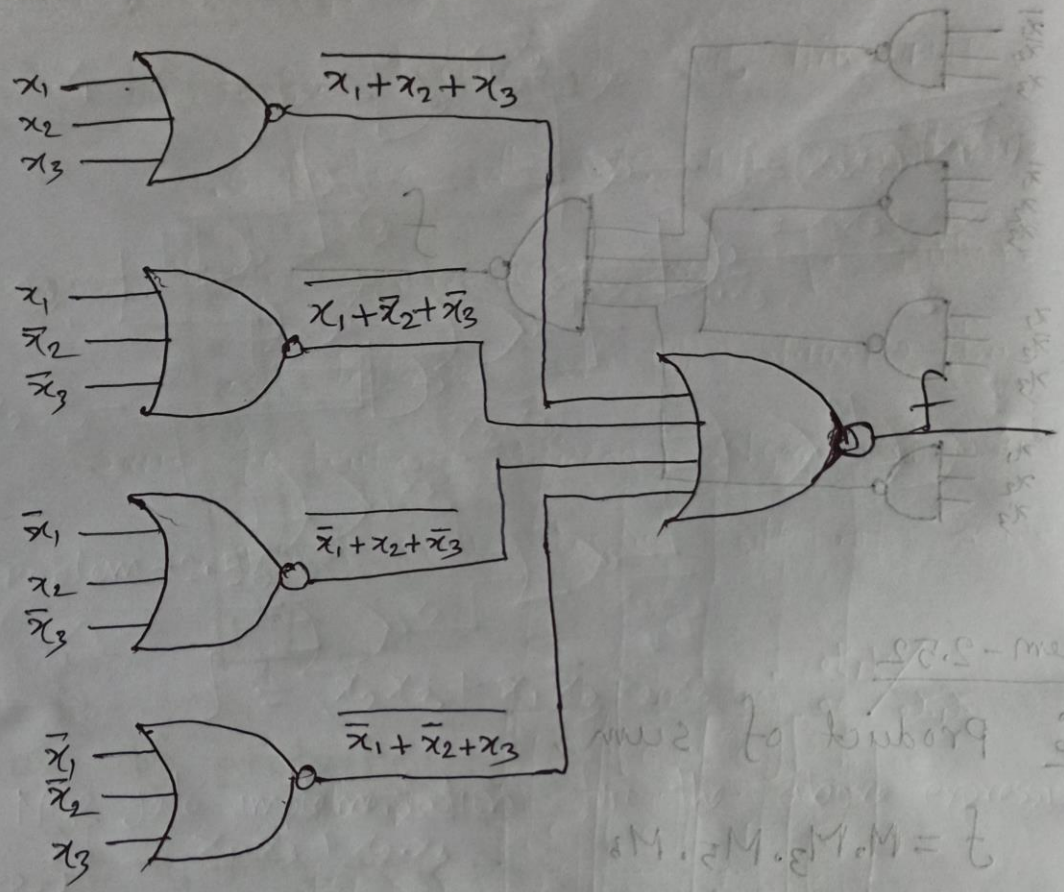
Soln: Product of sum,

$$f = M_0 \cdot M_3 \cdot M_5 \cdot M_6$$

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

$$\Rightarrow f = \overline{\left(\overline{(x_1 + x_2 + x_3)(x_1 + \bar{x}_2 + \bar{x}_3)(\bar{x}_1 + x_2 + \bar{x}_3)(\bar{x}_1 + \bar{x}_2 + x_3)}\right)}$$

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



Problem- 2.54

Soln:

x_1	x_2	x_3	Minterm (SSOP)
0	0	0	$\bar{x}_1\bar{x}_2\bar{x}_3 \rightarrow m_0$
0	0	1	$\bar{x}_1\bar{x}_2x_3 \rightarrow m_1$
0	1	0	$\bar{x}_1x_2\bar{x}_3 \rightarrow m_2$
0	1	1	$\bar{x}_1x_2x_3 \rightarrow m_3$
1	0	0	$x_1\bar{x}_2\bar{x}_3 \rightarrow m_4$
1	0	1	$x_1\bar{x}_2x_3 \rightarrow m_5$
1	1	0	$x_1x_2\bar{x}_3 \rightarrow m_6$
1	1	1	$x_1x_2x_3 \rightarrow m_7$

$$f(x_1,x_2,x_3) = \sum m(3,4,6,7) = m_3+m_4+m_6+m_7$$

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

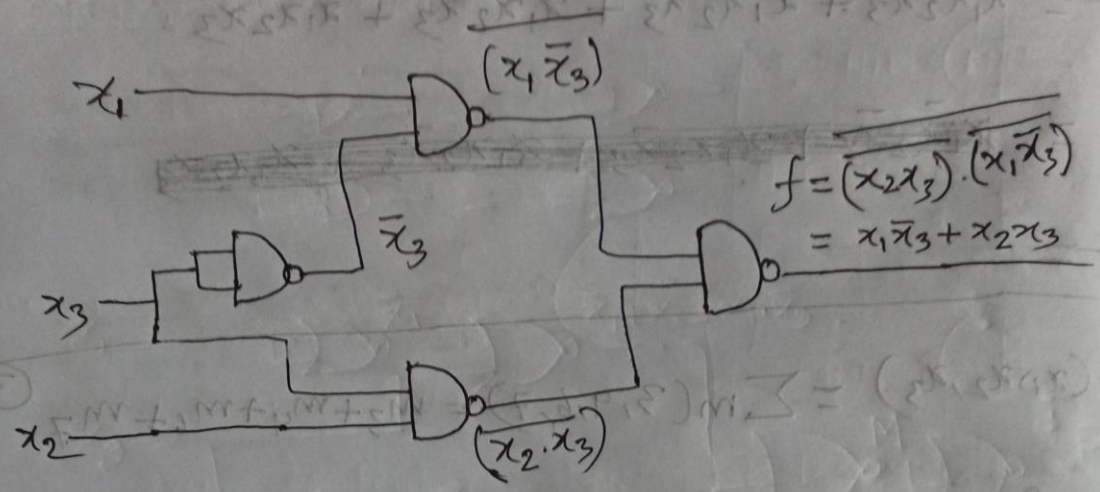
$$\Rightarrow f = \bar{x}_1 x_2 x_3 + x_1 x_2 x_3 + x_1 \bar{x}_2 \bar{x}_3 + x_1 x_2 \bar{x}_3$$

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

Design Using NAND gates:

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

$$= \overline{\overline{x_2 x_3 + x_1 \bar{x}_3}} = \overline{\overline{(x_2 x_3)} \cdot \overline{(x_1 \bar{x}_3)}}$$

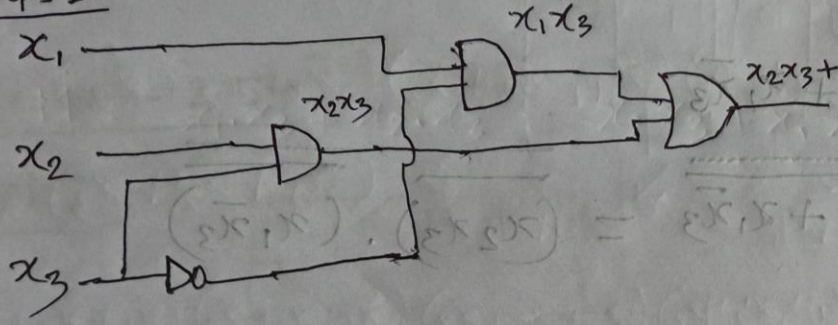


Problem-2.56

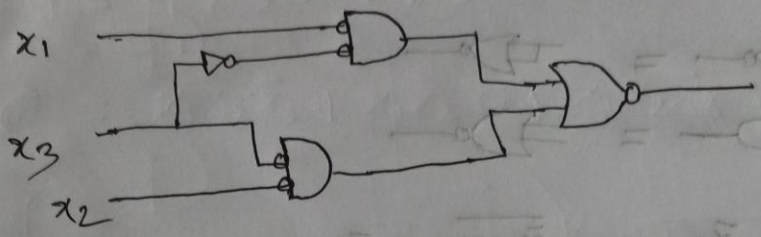
Soln: $f = x_2x_3 + x_1\bar{x}_3$

NOR gate implementation for the above expression.

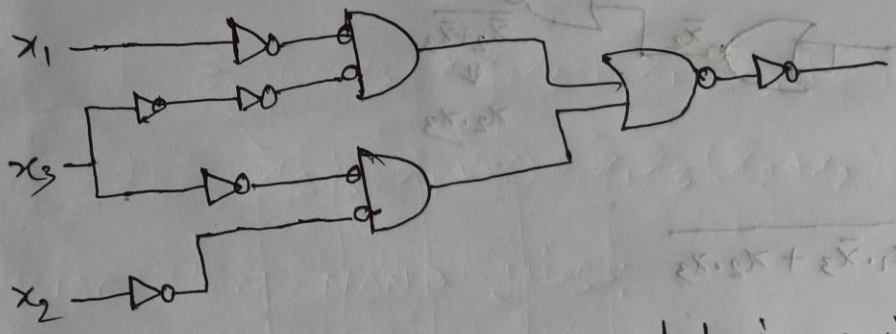
Step-1:



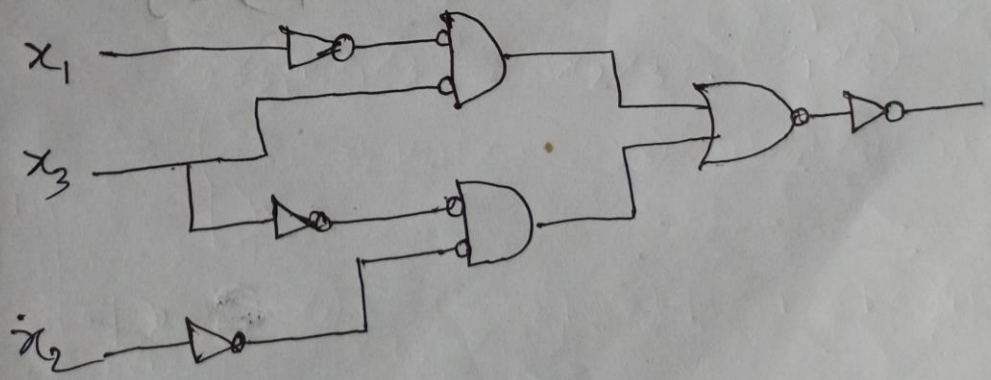
Step-2: Apply bubble at o/p of OR gate and at I/P of AND Gate.



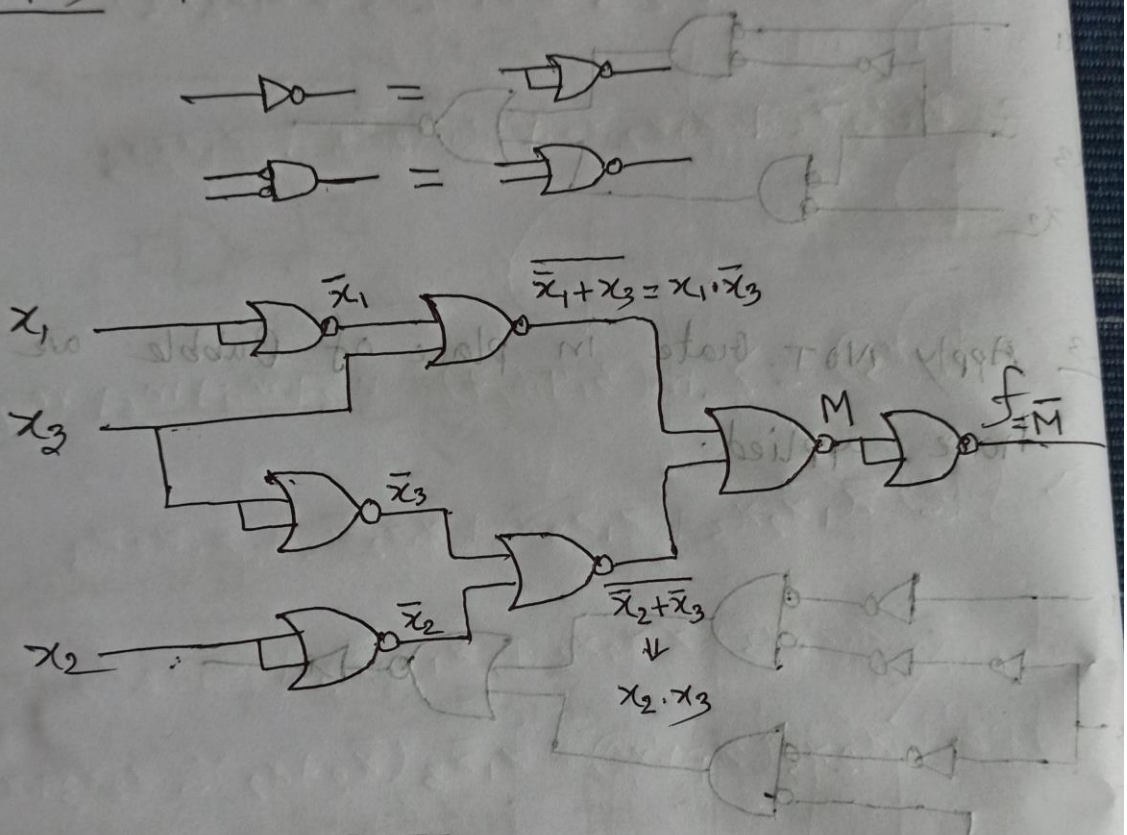
Step-3 Apply NOT Gate in place of Bubble we have applied.



Step-4 Cancel NOT gates connected in series.



Step-5: place NOR gate equivalent.



$$\therefore M = \overline{x_1 \cdot \bar{x}_3 + x_2 \cdot x_3}$$

$$\therefore \bar{M} = \overline{\overline{x_1 \cdot \bar{x}_3 + x_2 \cdot x_3}} = x_2 x_3 + x_1 \bar{x}_3 = f$$