Shahjalal University of Science &Technology, Sylhet

Department of Computer Science and Engineering

Course No: EEE-201D

Assignment No: 01

Digital Logic Design

Submitted To

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Problem Statement:

Express each of the function in sum-of-minterms and product of maxterms form.

a) $(xy+z)(y+xz)$

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

Solution:

a) Expression in sum-of-minterms form-

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

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

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

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

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

Expression in product of maxterms:

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

b)

Expression in sum-of-minterms-

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

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

$$= wx\bar{y}z + w\bar{x}\bar{y}z + \bar{w}x\bar{y}z + \bar{w}\bar{x}\bar{y}z + wx\bar{y}z + wx\bar{y}\bar{z} + wxy\bar{z} + wx\bar{y}\bar{z} + \bar{w}\bar{x}yz + \bar{w}\bar{x}\bar{y}z$$

$$= wx\bar{y}z + w\bar{x}\bar{y}z + \bar{w}x\bar{y}z + \bar{w}\bar{x}\bar{y}z + wx\bar{y}\bar{z} + wxy\bar{z} + \bar{w}\bar{x}yz$$

Expression in product of maxterms:

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

$$= m_{13} + m_9 + m_5 + m_1 + m_{12} + m_{14} + m_3$$

$$= \Sigma(1,3,5,9,12,13,14)$$

$$= \Pi(2,4,6,7,8,10,11,15)$$

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

(02)

Problem Statement:

Simplyfy the boolean expressions using K-maps.

a) $xyz + wy + wx\bar{y} + \bar{x}y$

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

Solution:

a)

$$f(w,x,y,z) = xyz + wy + wx\bar{y} + \bar{x}y$$

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

$$= wxyz + \bar{w}xyz + wxyz + wxy\bar{z} + w\bar{x}yz + w\bar{x}y\bar{z} + wx\bar{y}z + wx\bar{y}\bar{z} + w\bar{x}yz + w\bar{x}y\bar{z} + \bar{w}\bar{x}yz + \bar{w}\bar{x}y\bar{z}$$

$$= wxyz + \bar{w}xyz + wxy\bar{z} + w\bar{x}yz + w\bar{x}y\bar{z} + wx\bar{y}z + wx\bar{y}\bar{z} + \bar{w}\bar{x}yz + \bar{w}\bar{x}y\bar{z}$$

$$= m_{15} + m_7 + m_{14} + m_{11} + m_{10} + m_{13} + m_{12} + m_3 + m_2$$

$wx \backslash yz$	00	01	11	10
00	0	0	1	1
01	0	0	1	0
11	1	1	1	1
10	0	0	1	1

$$f(w,x,y,z) = wx + yz + wy + \bar{w}\bar{x}y$$

b)

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

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

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

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

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

$x \backslash yz$	00	01	11	10
0	1		1	1
1	1			1

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

(03)

Problem statement:

Implement the functions from question 1 with a 4X1 multiplexer and external gates.

Here,

$$f(w,x,y,z) = (xy+z)(y+xz)$$

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

$$= (w+\bar{w})xyz + (w+\bar{w})xy\bar{z} + (w+\bar{w})\bar{x}yz + (w+\bar{w})x\bar{y}z$$

$$= wxyz + \bar{w}xyz + wxy\bar{z} + \bar{w}xy\bar{z} + w\bar{x}yz + \bar{w}\bar{x}yz + wx\bar{y}z + \bar{w}x\bar{y}z$$

$$= m_{15} + m_7 + m_{14} + m_6 + m_{11} + m_3 + m_{13} + m_5$$

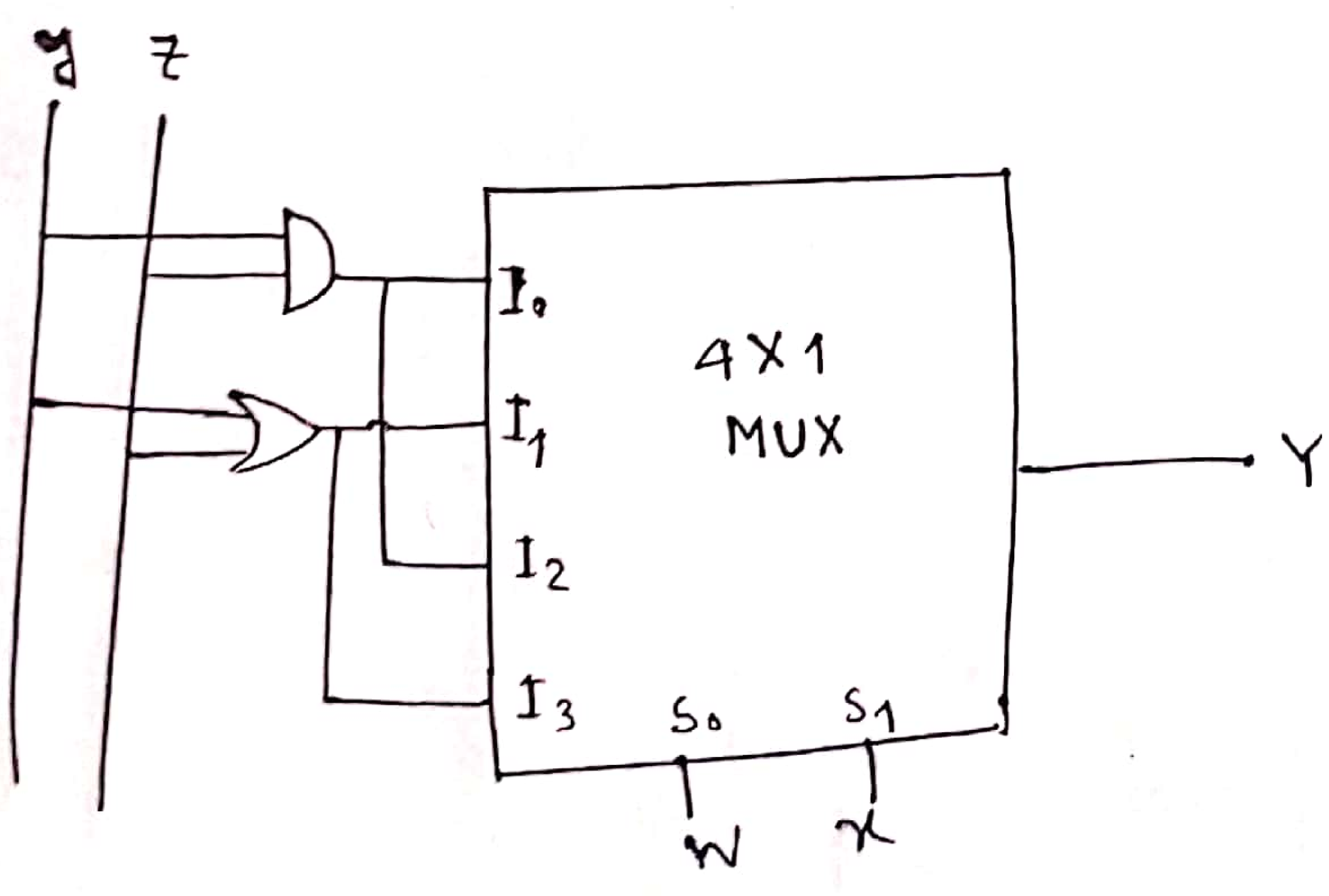
$S_0 S_1$ / wx \ yz	00	01	11	10
00	0	0	1	0
01	0	1	1	1
11	0	1	1	1
10	0	0	1	0

$I_0 = yz$

$I_1 = z+y$

$I_2 = yz$

$I_3 = z+y$



b)

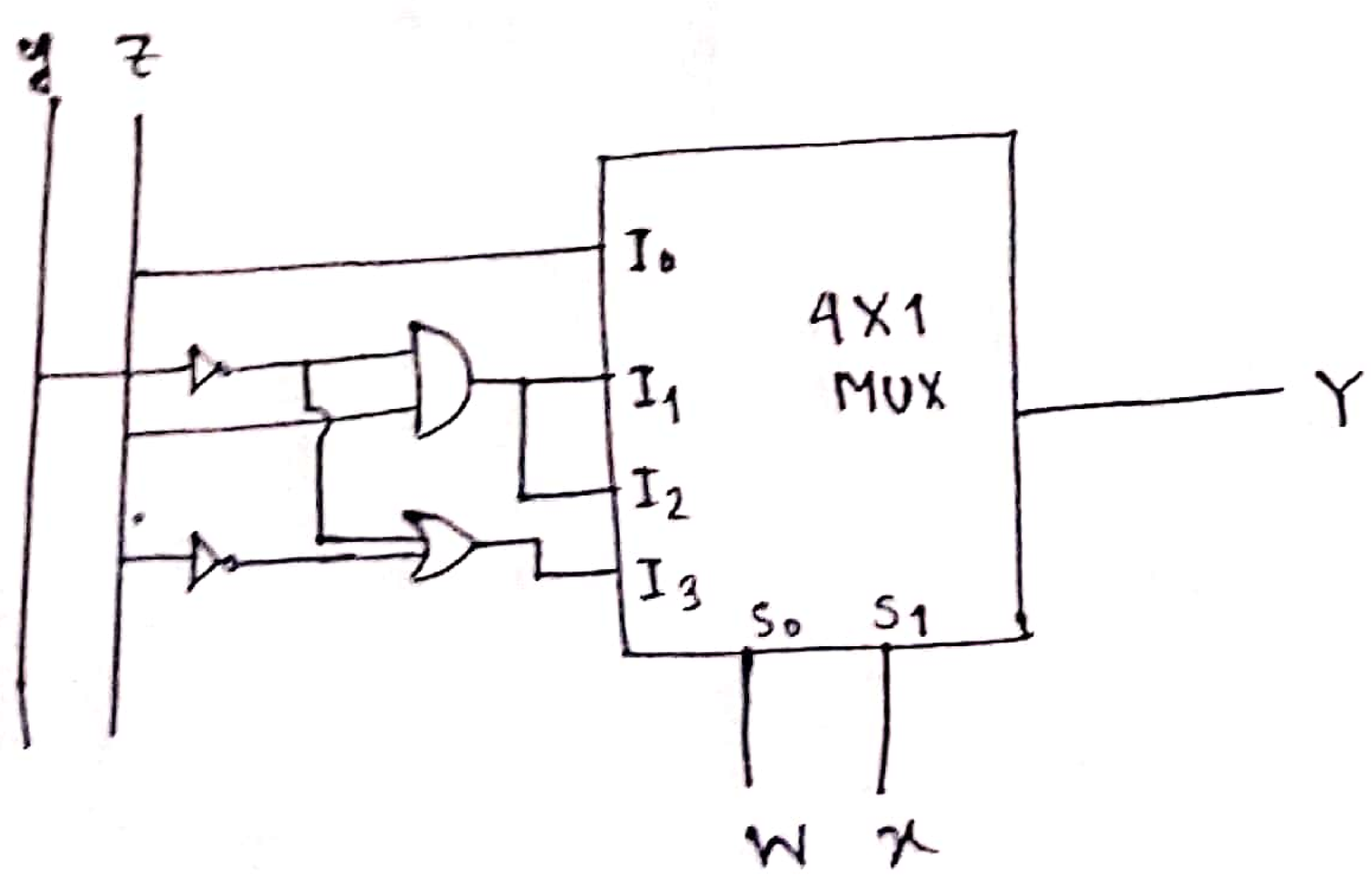
$$f(w,x,y,z) = \bar{y}z + wx\bar{y} + wx\bar{z} + \bar{w}\bar{x}z$$

$$= wx\bar{y}z + w\bar{x}\bar{y}z + \bar{w}x\bar{y}z + \bar{w}\bar{x}\bar{y}z$$
$$+ wx\bar{y}\bar{z} + wxy\bar{z} + \bar{w}\bar{x}yz$$

$$= m_{13} + m_9 + m_5 + m_1 + m_{12} + m_{14} + m_3$$

wx \ yz	00	01	11	10
00	0	1	1	0
01	0	1	0	0
11	1	1	0	1
10	0	1	0	0

$I_0 = z$
$I_1 = \bar{y}z$
$I_2 = \bar{y}z$
$I_3 = \bar{y} + \bar{z}$



Problem statement:

Design a four-bit combinational circuit 2's complementer.

(The output generates the 2's complement of the input binary number).

Solution:

Input					Output			
w	x	y	z		F_3	F_2	F_1	F_0
0	0	0	0		0	0	0	0
0	0	0	1		1	1	1	1
0	0	1	0		1	1	1	0
0	0	1	1		1	1	0	1
0	1	0	0		1	1	0	0
0	1	0	1		1	0	1	1
0	1	1	0		1	0	1	0
0	1	1	1		1	0	0	1
1	0	0	0		1	0	0	0
1	0	0	1		0	1	1	1
1	0	1	0		0	1	1	0
1	0	1	1		0	1	0	1
1	1	0	0		0	1	0	0
1	1	0	1		0	0	1	1
1	1	1	0		0	0	1	0
1	1	1	1		0	0	0	1

For F_3:

wx \ yz	00	01	11	10
00	0	1	1	1
01	1	1	1	1
11	0	0	0	0
10	1	0	0	0

$$F_3 = \bar{w}z + \bar{w}y + \bar{w}x\bar{y} + w\bar{x}\bar{y}\bar{z}$$

For F_2:

wx \ yz	00	01	11	10
00	0	1	1	1
01	1	0	0	0
11	1	0	0	0
10	0	1	1	1

$$F_2 = x\bar{y}\bar{z} + \bar{x}z + \bar{x}y$$

For F_1:

wx \ yz	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	1	0	1
10	0	1	0	1

$$F_1 = \bar{y}z + y\bar{z}$$

For F_0:

wx \ yz	00	01	11	10
00	0	1	1	0
01	0	1	1	0
11	0	1	1	0
10	0	1	1	0

$$F_0 = z$$

Here,

$F_3 = \bar{w}z + \bar{w}y + \bar{w}x\bar{y} + w\bar{x}\bar{y}\bar{z}$

$F_2 = x\bar{y}\bar{z} + \bar{x}z + \bar{x}y$

$F_1 = \bar{y}z + y\bar{z}$

$F_0 = z$