Assignment-3

1) Design a combinational circuit for a gray to BCD code using (a) standard logic gates, (b) decoder, (c) 8 to 1 multiplexer and (d) 4 to 1 multiplexer.

(a)

Input (Gray)				Output (BCD)			
G_3	G_2	G_1	G_0	B_3	B_2	B_1	B_0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	1	0	0	1	0
0	0	1	0	0	0	1	1
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0
0	1	0	0	0	1	1	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	1	x	x	x	x
1	1	1	0	x	x	x	x
1	0	1	0	x	x	x	x
1	0	1	1	x	x	x	x
1	0	0	1	x	x	x	x
1	0	0	0	x	x	x	x

$n = 4 \Rightarrow 2^n$ rows

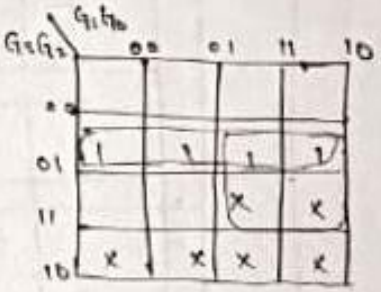
$\Rightarrow 2^4 = 16$ rows

In BCD, 0-9 are valid

10-15 are Invalid.

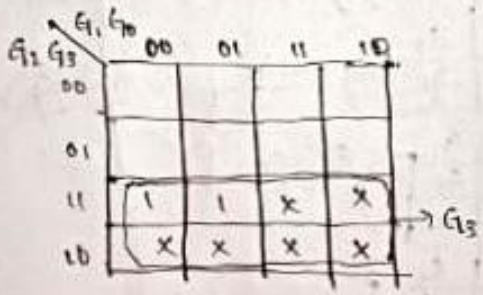
Hence 10-15 are considered as Don't care.

K-Map for B_2



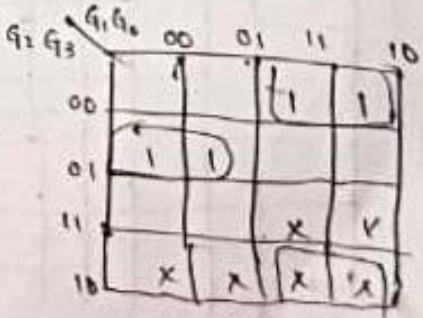
$\therefore B_2 = \bar{G}_3 G_2 + G_2 G_1$

K-Map for B_3



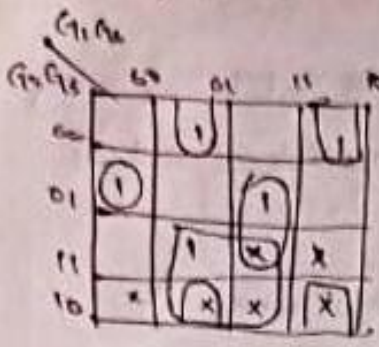
$\therefore B_3 = G_3$

K-Map for B_1

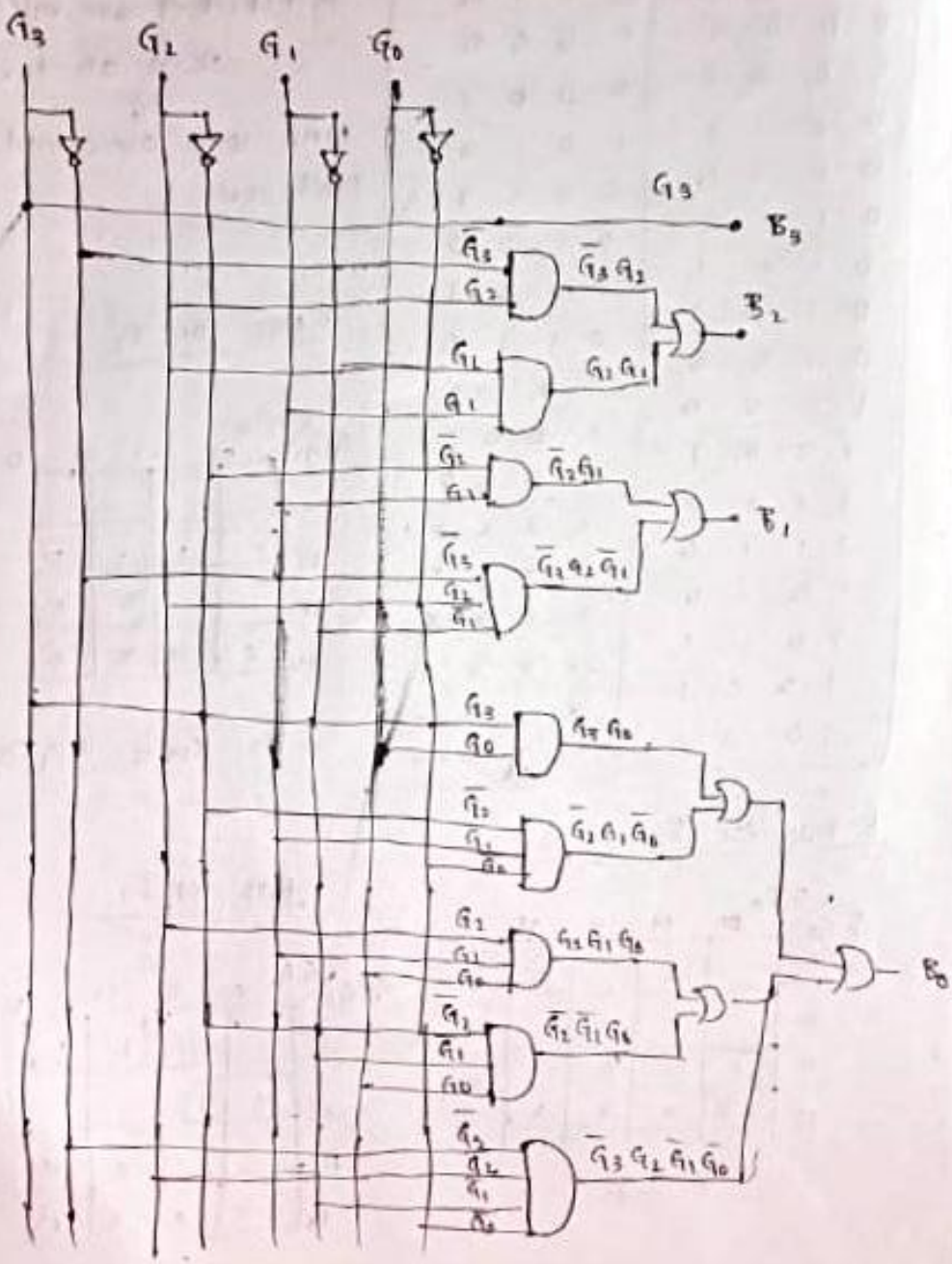


$\therefore B_1 = \bar{G}_2 G_1 + \bar{G}_3 G_2 \bar{G}_1$

K-Map for B_0



$$\therefore B_0 = G_3G_0 + \bar{G}_2G_1\bar{G}_0 + G_2G_1G_0 + G_3\bar{G}_1G_0 + \bar{G}_3G_2\bar{G}_1\bar{G}_0$$



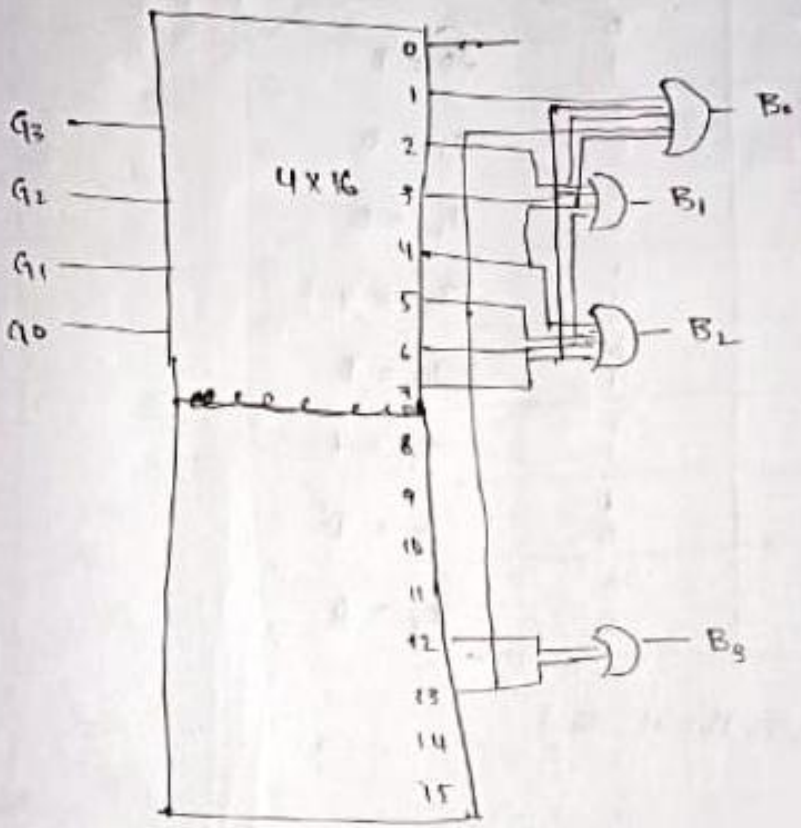
(b) Using Decoder

$B_3 = \Sigma(12, 13)$

$B_2 = \Sigma(6, 7, 5, 4)$

$B_1 = \Sigma(3, 2, 5, 4)$

$B_0 = \Sigma(1, 2, 7, 4, 13)$



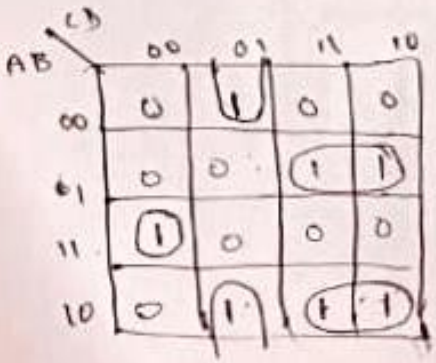
(c) Using 4 x 1 multiplexer

(2) An 8 to 1 MUX has inputs A, B, and C connected to selection lines S_2, S_1 and S_0 respectively. The data inputs I_0 & I_1 are connected as $I_1 = I_2 = I_4 = 0$; $I_3 = I_5 = 1$, $I_0 = I_4 = D$ and $I_6 = D'$. Determine the Boolean expression of the MUX output.

$I_1 = I_2 = I_4 = 0$; $I_3 = I_5 = 1$; $I_0 = I_4 = D$; & $I_6 = D'$

Inputs				Outputs	
A	B	C	D	F	
0	0	0	0	0	$I_0 = D$
0	0	0	1	1	
0	0	1	0	0	$I_1 = 0$
0	0	1	1	0	
0	1	0	0	0	$I_2 = 0$
0	1	0	1	0	
0	1	1	0	1	$I_3 = 1$
0	1	1	1	1	
1	0	0	0	0	$I_4 = D$
1	0	0	1	1	
1	0	1	0	1	$I_5 = 1$
1	0	1	1	1	
1	1	0	0	1	$I_6 = D'$
1	1	0	1	0	
1	1	1	0	0	$I_7 = 0$
1	1	1	1	0	

$F = \sum (1, 6, 7, 9, 10, 11, 12)$



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

3. Implement the Boolean function $F(A,B,C,D) = \Sigma(1,3,4,11,12,13,15)$ using (a) decoder and external gates and (b) 8 to 1 MUX and external gates.

Minterm Number	A	B	C	D	F
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	0
3	0	0	1	1	1
4	0	1	0	0	1
5	0	1	0	1	0
6	0	1	1	0	0
7	0	1	1	1	0
8	1	0	0	0	0
9	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	1
12	1	1	0	0	1
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	1

$n = 4$

$2^n = 2^4 = 16\ (0-15)$

(b)

No. of Selection input lines in 8x1 MUX $8 \times 1 \Rightarrow 2^n \times 1 \Rightarrow 2^3 \times 1$

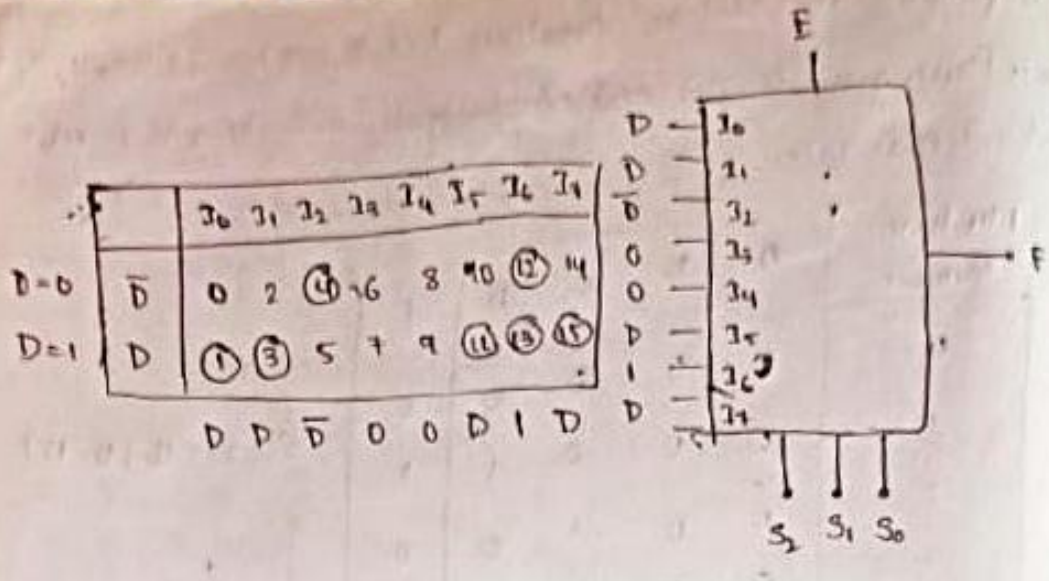
No. of Selection inputs = 3 (S_2, S_1, S_0)

No. of Input variables = no of selection variables

$4 \neq 3$

ABC - Selection inputs.

D - input variable



(a) Using a decoder

$$F(A,B,C,D) = \Sigma(1,3,4,11,12,13,15)$$