LAB - 3 : Design and Implement code converter
i> Binary to Gray
ii> Gray to Binary code using basic gates.

To realise binary to gray code

Binary code: code used in digital computers based on a binary numbers system in which there are only two possible states, off and on, usually symbolized by 0 and 1

Steps need to follow while converting.

1> Recode the MSB as it is.
2> Add the MSB to next bit, record the sum and neglect the carry.
3> Repeat the process

Binary to gray code.

Example:

Sum 1 0 1 0 (Binary code)

↓ 1 0 1

1 1 1 1 (Grade code)

EX-OR.

Binary to gray code.

No	Binary				Grey			
	B_3	B_2	B_1	B_0	G_3	G_2	G_1	G_0
0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	0
5	0	1	0	1	0	1	1	1
6	0	1	1	0	0	1	0	1
7	0	1	1	1	0	1	1	0
8	1	0	0	0	1	1	0	0
9	1	0	0	1	1	1	0	1
10	1	0	1	0	1	1	1	1
11	1	0	1	1	1	1	1	0
12	1	1	0	0	1	0	1	0
13	1	1	0	1	1	0	1	1
14	1	1	1	0	1	0	0	1
15	1	1	1	1	1	0	0	0

Binary to gray code k-map.

B_1B_0 \ B_3B_2	00	01	11	10
00	0	0	1	1
01	0	0	1	1
11	0	0	1	1
10	0	0	1	1

$G_3 = B_3$

B_1B_0 \ B_3B_2	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	1	0	1
10	0	1	0	1

$G_2 = \overline{B_3} B_2 + B_3 \overline{B_2}$

B_1B_0 \ B_3B_2				
00	0	1	1	0
01	0	1	1	0
11	1	0	0	1
10	1	0	0	1

B_1B_0 \ B_3B_2	00	01	11	10
00	0	0	0	0
01	1	1	1	1
11	0	0	0	0
10	1	1	1	1

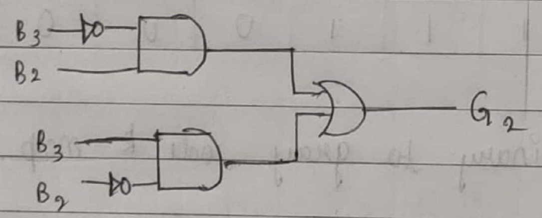
$G_1 = \bar{B}_2 B_1 + B_2 \bar{B}_1$

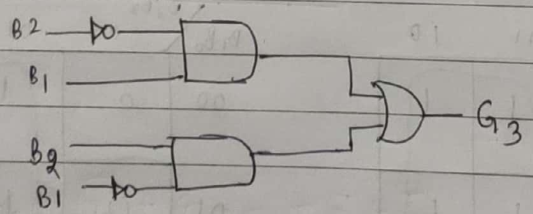
$G_1 = B_2 \oplus B_1$

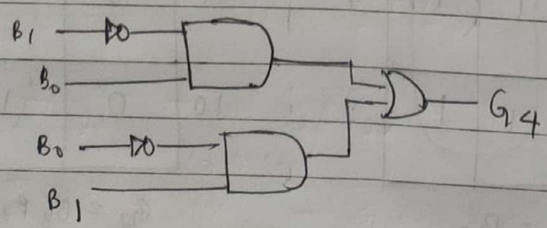
$G_0 = \bar{B}_1 B_2 + B_1 \bar{B}_0$

$= B_1 \oplus B_0$

Binary to Gray code circuit diagram.







Gray to Binary Code.

Gray code: The reflected binary code, also known just as reflected binary or gray code after Frank Gray, is an ordering of the binary numeral system such that two successive values differ in only one bit.

Binary number is converted to gray code to reduce switching operations.

Applications: Error correction in digital communication such as digital television and some cable TV systems and reliability of the switching systems is Improved.

Gray to Binary Code.

No	Gray				Binary			
	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
1	0	0	0	1	0	0	0	1
2	0	0	1	0	0	0	1	1
3	0	0	1	1	0	0	1	0
4	0	1	0	0	0	1	1	1
5	0	1	0	1	0	1	1	0
6	0	1	1	0	0	1	0	0
7	0	1	1	1	0	1	0	1
8	1	0	0	0	1	1	1	1
9	1	0	0	1	1	1	1	0
10	1	0	1	0	1	1	0	0
11	1	0	1	1	1	1	0	1
12	1	0	0	0	1	0	0	0
13	1	0	0	1	1	0	0	1
14	1	0	1	0	1	0	1	1
15	1	0	1	1	1	0	1	0

Gray to Binary code K-Map

G_1G_0 \ G_3G_2	00	01	11	10
00	0	0	1	1
01	0	0	1	1
11	0	0	1	1
10	0	0	1	1

G_1G_0 \ G_3G_2	00	01	11	10
00	0	1	0	1
01	0	1	0	1
11	0	1	0	1
10	0	1	0	1

$B_3 = G_3$

$B_2 = G_3\bar{G}_2 + \bar{G}_3G_2$

$B_2 = G_3 \oplus G_2$

G_1G_0 \ G_3G_2	$\bar{G}_3\bar{G}_2$ 00	$\bar{G}_3G_2$ 01	G_3G_2 11	$G_3\bar{G}_2$ 10
$\bar{G}_1\bar{G}_0$ 00	0	1	0	1
$\bar{G}_1G_0$ 01	0	1	0	1
G_1G_0 11	1	0	1	0
$G_1\bar{G}_0$ 10	1	0	1	0

G_1G_0 \ G_3G_2	$\bar{G}_3\bar{G}_2$ 00	$\bar{G}_3G_2$ 01	G_3G_2 11	$G_3\bar{G}_2$ 10
$\bar{G}_1\bar{G}_0$ 00	0	1	0	1
$\bar{G}_1G_0$ 01	1	0	1	0
G_1G_0 11	0	1	0	1
$G_1\bar{G}_0$ 10	1	0	1	0

$B_1 = G_3 \oplus G_2 \oplus G_1$

$B_1 = \bar{G}_1\bar{G}_3G_2 + G_1\bar{G}_3\bar{G}_2 + G_3G_2G_1 + \bar{G}_1G_3\bar{G}_2$

$\Rightarrow \bar{G}_1(\bar{G}_3G_2 + G_3\bar{G}_2) + G_1(\bar{G}_3\bar{G}_2 + G_2G_3)$

$\Rightarrow \bar{G}_1(G_3 \oplus G_2) + G_1(\overline{G_3 \oplus G_2})$

$X = G_3 \oplus G_2$

$\Rightarrow \bar{G}_1X + G_1\bar{X} = G_1 \oplus G_2 \oplus G_3$

$$B_0 = \bar{G}_3 G_2 \bar{G}_1 \bar{G}_0 + G_3 \bar{G}_2 \bar{G}_1 \bar{G}_0 + \bar{G}_3 \bar{G}_2 \bar{G}_1 G_0 + G_3 G_2 \bar{G}_1 G_0$$

$$\bar{G}_3 G_2 G_1 G_0 + G_3 \bar{G}_2 G_1 G_0 + \bar{G}_3 \bar{G}_2 G_1 \bar{G}_0 + G_3 G_2 G_1 \bar{G}_0$$

$$\Rightarrow \bar{G}_3 \bar{G}_2 (\bar{G}_1 G_0 + G_1 \bar{G}_0) + G_3 G_2 (\bar{G}_1 G_0 + \bar{G}_1 G_0)$$

$$\bar{G}_3 G_2 (\bar{G}_1 \bar{G}_0 + G_1 G_0) + G_3 \bar{G}_2 (\bar{G}_1 \bar{G}_0 + G_1 G_0)$$

$$\Rightarrow \bar{G}_3 \bar{G}_2 (G_1 \oplus G_0) + G_3 G_2 (G_1 \oplus G_0)$$

$$\bar{G}_3 G_2 (\overline{G_1 \oplus G_0}) + G_3 \bar{G}_2 (\overline{G_1 \oplus G_0})$$

$$\Rightarrow \overline{G_1 \oplus G_0} [\bar{G}_3 G_2 + G_3 \bar{G}_2] + G_1 \oplus G_0 [\bar{G}_3 \bar{G}_2 + G_3 G_2]$$

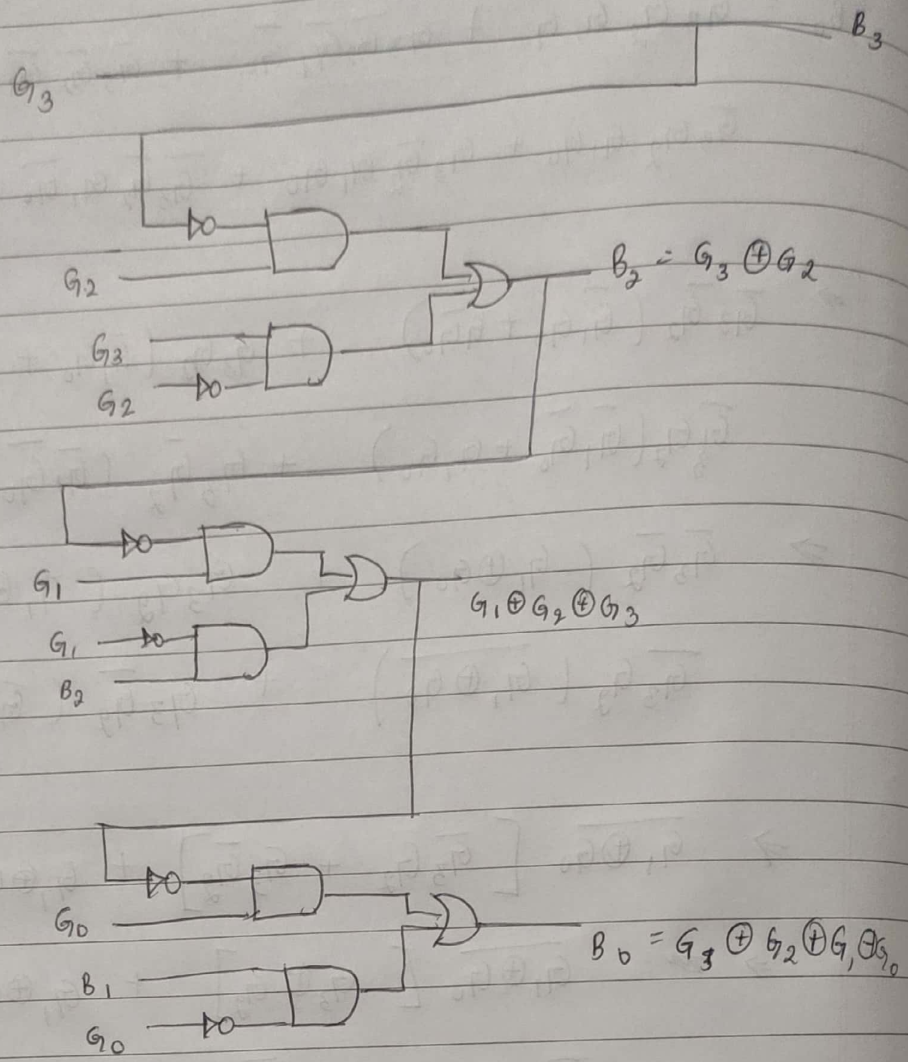
$$\Rightarrow \overline{G_1 \oplus G_0} [G_3 \oplus G_2] + G_1 \oplus G_0 [G_3 \oplus G_2]$$

$$\Rightarrow \bar{X} Y + X \bar{Y}$$

$$\Rightarrow X \oplus Y$$

$$\Rightarrow G_3 \oplus G_2 \oplus G_1 \oplus G_0$$

Gray to Binary code circuit diagram


B3
G3
G2
B2 = G3 ⊕ G2
G3
G2
G1
G1 ⊕ G2 ⊕ G3
G1
B2
G0
B1
G0
B0 = G3 ⊕ G2 ⊕ G1 ⊕ G0