LAB REPORT

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Computer Science and Engineering

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Section	:	B
Semester	:	2nd Semester
Experiment No	:	04

Experiment name: Binary to Gray Code Converter

AIM: To realize Binary to Gray Code coverter and Vice versa.

Learning Objective:

1. To learn the importance of non-weighted Code.
2. To learn to generate gray code.

Components required: IC 7402, Patch Card.

IC Trainer kit

(i) Binary to Gray Code Converter:

Truth Table:

Binary (input)				Gray Code (output)			
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	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0

Binary (input)				Gray Code (output)			
B_3	B_2	B_1	B_0	G_3	G_2	G_1	G_0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

Karnaugh Map:

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

$G_3 = B_3$

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

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

$= B_3 \oplus B_2$

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

$G_1 = \overline{B_1}B_2 + \overline{B_2}B_1 = B_1 \oplus B_2$

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

$G_0 = B_1\overline{B_0} + \overline{B_1}B_0$

$= B_1 \oplus B_0$

Boolean Expression (Basic Gates):

$G_3 = B_3$

$G_2 = B_2 \oplus B_3$

$G_1 = B_1 \oplus B_2$

$G_0 = B_0 \oplus B_1$

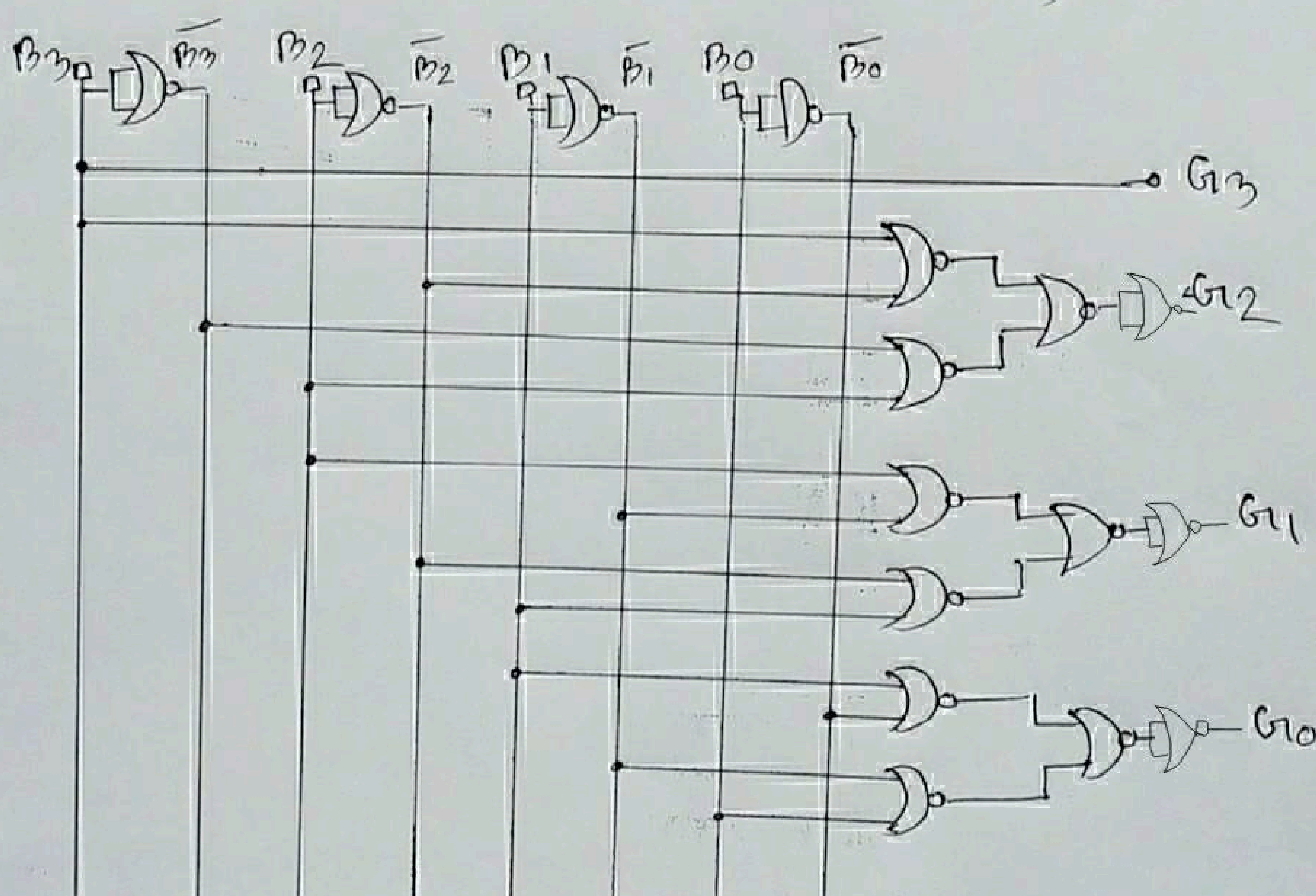
Realization using NOR gates:

$G_3 = \overline{\overline{B_3}}$

$G_2 = \overline{\overline{B_2 \oplus B_3}} = \overline{B_2 B_3 + \bar{B}_2 \bar{B}_3} = \overline{\overline{(\bar{B}_2 + \bar{B}_3)} + \overline{(B_2 + B_3)}}$

$G_1 = \overline{\overline{B_1 \oplus B_2}} = \overline{B_1 B_2 + \bar{B}_1 \bar{B}_2} = \overline{\overline{(\bar{B}_1 + \bar{B}_2)} + \overline{(B_1 + B_2)}}$

$G_0 = \overline{\overline{B_0 \oplus B_1}} = \overline{B_0 B_1 + \bar{B}_0 \bar{B}_1} = \overline{\overline{(\bar{B}_0 + \bar{B}_1)} + \overline{(B_0 + B_1)}}$



(ii) Gray to Binary Code Converter:

Truth Table:

Gray code (input)				Binary output			
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	1	0	1	0
1	1	1	0	1	0	1	1
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	0	0	1	1	1	1	0
1	0	0	0	1	1	1	1

K.Map :

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

$B_3 = G_3$

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

$$B_2 = G_3\overline{G_2} + G_2\overline{G_3}$$
$$= G_3 \oplus G_2$$

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

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

$$B_1 = G_1\overline{G_2}\,\overline{G_3} + \overline{G_1}\,\overline{G_3}\,G_2 + G_1G_2G_3 + \overline{G_1}\,\overline{G_2}\,G_3$$
$$= \overline{G_3}(G_1\overline{G_2} + \overline{G_1}G_2) + G_3(G_1G_2 + \overline{G_1}\,\overline{G_2})$$
$$= \overline{G_3}(G_1 \oplus G_2) + G_3\overline{(G_1 \oplus G_2)}$$
$$= (G_1 \oplus G_2 \oplus G_3)$$

$$B_0 = G_0\overline{G_1}\,\overline{G_2}\,\overline{G_3} + \overline{G_0}G_1\overline{G_2}\,\overline{G_3} + \overline{G_0}\,\overline{G_1}G_2\overline{G_3} + G_0G_1G_2\overline{G_3} + G_0\overline{G_1}G_2G_3 + \overline{G_0}G_1G_2G_3 + \overline{G_0}\,\overline{G_1}\,\overline{G_2}G_3 + G_0G_1\overline{G_2}G_3$$
$$= \overline{G_2}\,\overline{G_3}(G_0\overline{G_1} + \overline{G_0}G_1) + G_2\overline{G_3}(\overline{G_0}\,\overline{G_1} + G_0G_1) + G_2G_3(G_0\overline{G_1} + \overline{G_0}G_1) + \overline{G_2}G_3(\overline{G_0}\,\overline{G_1} + G_0G_1)$$

$$B_0 = \overline{G_2}\,\overline{G_3}(G_0 \oplus G_1) + G_2\overline{G_3}\,\overline{(G_0 \oplus G_1)} + G_2G_3(G_0 \oplus G_1) + \overline{G_2}G_3\overline{(G_0 \oplus G_1)}$$

$$B_0 = (G_0 \oplus G_1)(\bar{G_2}\bar{G_3} + G_2G_3) + (\overline{G_0 \oplus G_1})(G_2\bar{G_3} + \bar{G_2}G_3)$$
$$= (G_0 \oplus G_1)(\overline{G_2 \oplus G_3}) + (\overline{G_0 \oplus G_1})(G_2 \oplus G_3)$$
$$= (G_0 \oplus G_1 \oplus G_2 \oplus G_3)$$

<u>Boolean Expression</u>

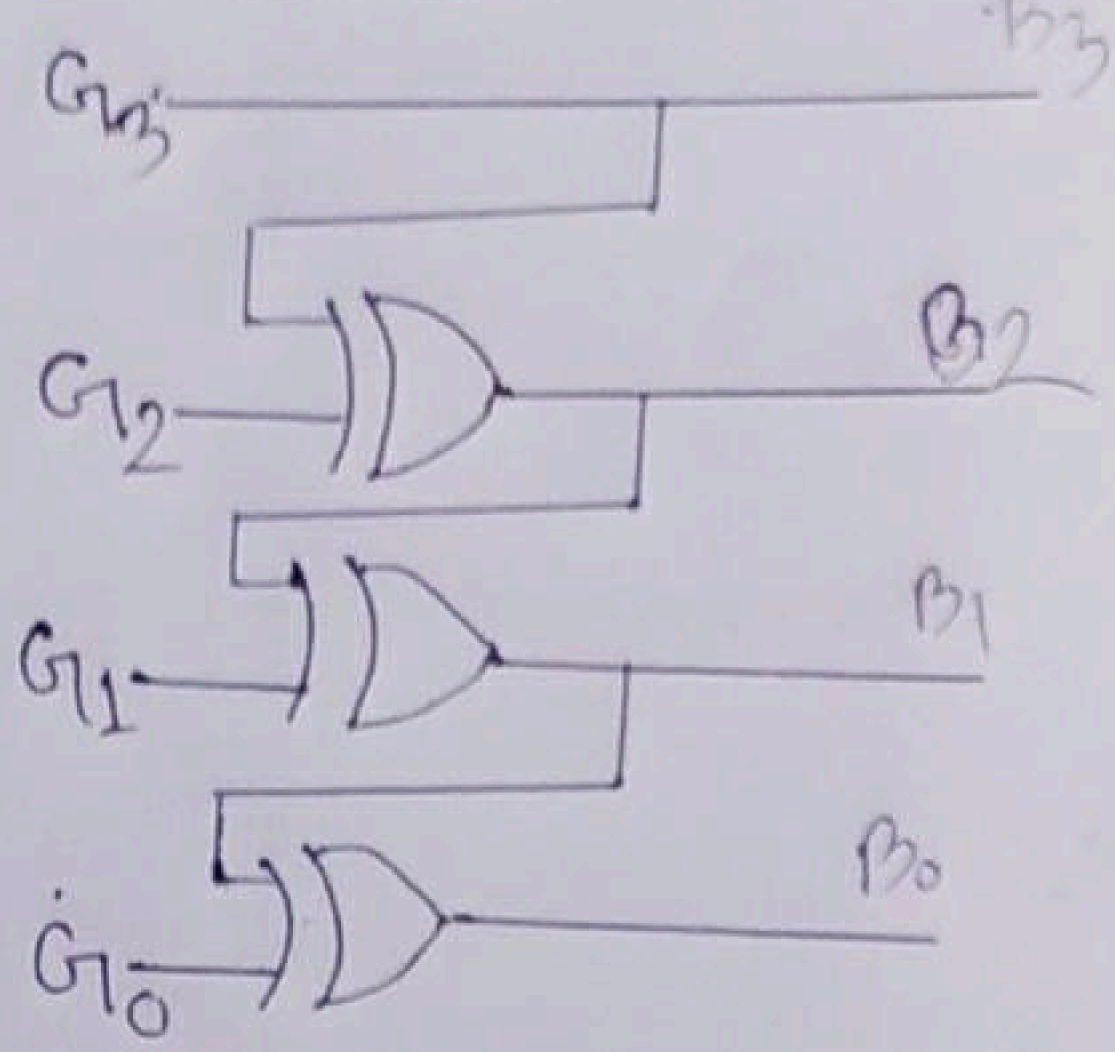
$B_3 = G_3$

$B_2 = G_3 \oplus G_2$

$B_1 = G_3 \oplus G_2 \oplus G_1$

$B_0 = G_3 \oplus G_2 \oplus G_1 \oplus G_0$

<u>Basic Gates</u>



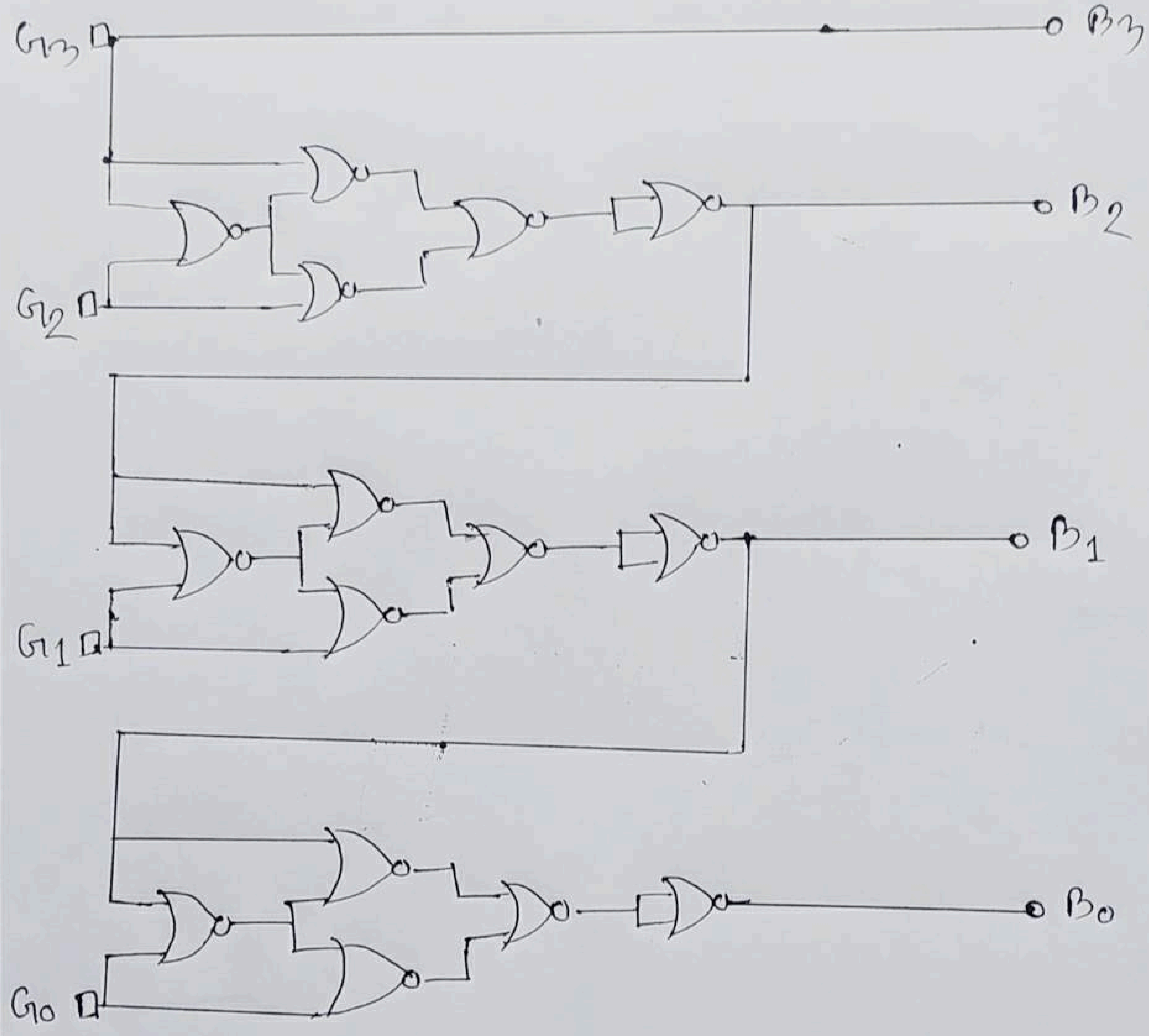
Realizing Using NOR Gates:

$$B_3 = \overline{\overline{G_3}}$$

$$B_2 = \overline{\overline{G_3 \oplus G_2}} = \overline{G_3G_2 + \bar{G_3}\bar{G_2}} = \overline{(\overline{\bar{G_3}+\bar{G_2}}) + (\overline{G_3+G_2})}$$

$$B_1 = \overline{\overline{G_3 \oplus G_2 \oplus G_1}} = \overline{\overline{B_2 \oplus G_1}} \quad [B_2 = G_3 \oplus G_2]$$
$$= \overline{B_2G_1 + \bar{B_2}\bar{G_1}} = \overline{(\overline{\bar{B_2}+\bar{G_1}}) + (\overline{B_2+G_1})}$$

$$B_0 = \overline{\overline{G_3 \oplus G_2 \oplus G_1 \oplus G_0}} = \overline{\overline{B_1 \oplus G_0}} \quad [B_1 = G_3 \oplus G_2 \oplus G_1]$$
$$= \overline{B_1G_0 + \bar{B_1}\bar{G_0}} = \overline{(\overline{\bar{B_1}+\bar{G_0}}) + (\overline{B_1+G_0})}$$



Procedure:

(i) All the Components were checked for their working.

(ii) The appropriate IC was inserted into the IC base

(iii) Connections were made as shown in the circuit diagram

(iv) The truth table was verified and the outputs were observed.

Result:

Binary to gray code conversion and vice versa is realized using X-OR gates & NOR gates.

Viva Question:

Q: What are Code Converters?

Ans: A converter that changes coded information to a different code system. One example of code conversion is to convert BCD to straight binary. The weighting of BCD bits is not the same as straight binary.

Q. What is the necessity of Code Conversions?

Ans: Code conversions are most commonly used in computers, digital electronics and microprocessors etc. There are numerous codes like binary, octal, hexadecimal, Binary-coded Decimal, Excess-3, Gray code etc. Error correcting Codes (ECCs) & ASCII code. Binary code is needed for the machine language because of the large number of bits required to store the binary code, octal, & hexadecimal are developed which are easy to write, understand and represent gray code are used in shaft encoders because, The code of successive numbers differs exactly by one bit from its preceder. XS-3 is extremely extensively used for subtractions because every code in XS-3 has its complement

1's complement of the code in yields 9's complement itself. Alphanumeric codes by ASCII standards are widely used as a representation system to the character set in computer. After all, the necessity of code conversion is so much.

Q. What is Gray Code?

Ans: A Gray code is an encoding of numbers so that adjacent numbers have a single digit differing by 1. The term gray code is often used to refers a "reflected" code or more specifically still the binary reflected Gray code.

Q.(a) Realize the Boolean expression for Binary to Gray Code conversion:

Ans: K. Map:

For G_3:

B_2B_3 \ B_1B_0	00	01	11	10
00	0	0	0	0
01	0	0	0	0
11	1	1	1	1
10	1	1	1	1

$G_3 = B_3$

For G_2:

B_2B_3 \ B_1B_0	00	01	11	10
00				
01	1	1	1	1
11				
10	1	1	1	1

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

For G_1:

B_2B_3 \ B_1B_0	00	01	11	10
00			1	1
01	1	1		
11			1	1
10	1	1		

$G_1 = \overline{B_1}B_2 + B_1\overline{B_2}$
$= B_1 \oplus B_2$

For G_0:

B_2B_3 \ B_1B_0	00	01	11	10
00		1		1
01		1		1
11		1		1
10		1		1

$G_0 = B_1\overline{B_0} + \overline{B_1}B_1$
$= B_0 \oplus B_1$

Q.(b) Realize the Boolean expression for Gray code to Binary conversion:

Ans:

K.Map :

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

$B_3 = G_3$

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

$B_2 = G_3\overline{G_2} + G_2\overline{G_3}$

$= G_3 \oplus G_2$

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

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

$B_1 = G_1\overline{G_2}\,\overline{G_3} + \overline{G_1}\,\overline{G_3}\,G_2 + G_1G_2G_3 + \overline{G_1}\,\overline{G_2}\,G_3$

$= \overline{G_3}(G_1\overline{G_2} + \overline{G_1}G_2) + G_3(G_1G_2 + \overline{G_1}\,\overline{G_2})$

$= \overline{G_3}(G_1 \oplus G_2) + G_3\overline{(G_1 \oplus G_2)}$

$= (G_1 \oplus G_2 \oplus G_3)$

$B_0 = G_0\overline{G_1}\,\overline{G_2}\,\overline{G_3} + \overline{G_0}G_1\overline{G_2}\,\overline{G_3} + \overline{G_0}\,\overline{G_1}G_2\overline{G_3} + G_0G_1G_2\overline{G_3} + G_0\overline{G_1}G_2G_3 + \overline{G_0}G_1G_2G_3 + \overline{G_0}\,\overline{G_1}\,\overline{G_2}G_3 + G_0G_1\overline{G_2}G_3$

$= \overline{G_2}\,\overline{G_3}(G_0\overline{G_1} + \overline{G_0}G_1) + G_2\overline{G_3}(\overline{G_0}\,\overline{G_1} + G_0G_1) + G_2G_3(G_0\overline{G_1} + \overline{G_0}G_1) + \overline{G_2}G_3(\overline{G_0}\,\overline{G_1} + G_0G_1)$

$B_0 = \overline{G_2}\,\overline{G_3}(G_0 \oplus G_1) + G_2\overline{G_3}\,\overline{(G_0 \oplus G_1)} + G_2G_3(G_0 \oplus G_1) + \overline{G_2}G_3\overline{(G_0 \oplus G_1)}$

$$B_0 = (G \oplus G_1)(\overline{G_2}\,\overline{G_3} + G_2 G_3) + (\overline{G_0 \oplus G_1})(G_2\overline{G_3} + \overline{G_2}G_3)$$

$$= (G_0 \oplus G_1)(\overline{G_2 \oplus G_3}) + (\overline{G_0 \oplus G_1})(G_2 \oplus G_3)$$

$$= G_0 \oplus G_1 \oplus G_2 \oplus G_3$$