CLASS: S.E. COMPUTER **SUBJECT: DEL**

EXPT. NO.: 2 **DATE:**

TITLE : Design and implement Code converters Binary to Gray and BCD to Excess 3

OBJECTIVE :

1. Design and Implement 4-bit Binary to Gray code converter using minimum number of logic gates and Vice-versa
2. Design and Implement Excess-3 to BCD code converter using minimum number of logic gates and Vice-versa

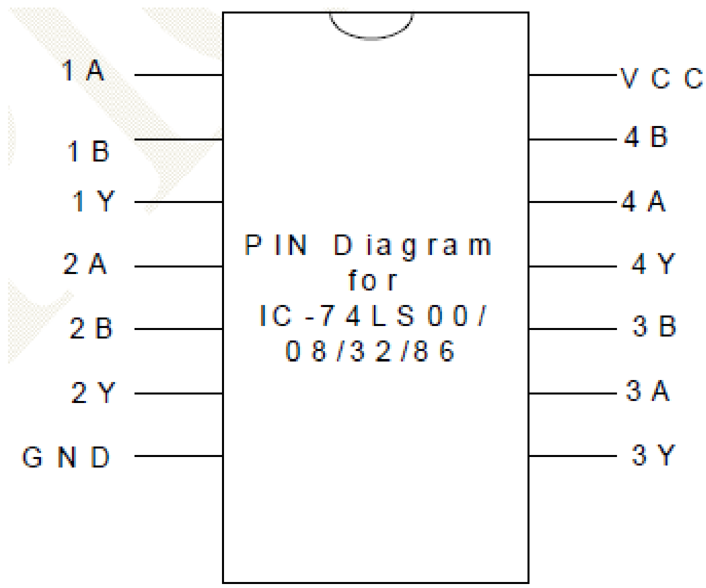
APPARATUS :

Digital-Board, GP-4Patch-Cords, IC-74LS86, IC-74LS32, IC-74LS08 / IC-74LS04 and Required Logic gates if any.

THEORY :

Code converter is combinational logic circuits, which can be used to convert one number system to another. Binary code is a weighted code having base 2.Gray code is a code in which one bit change is obtained; Gray code is also called *unit distance code or reflected code*. BCD code is basically a 4-bit binary code but it is valid from 0 to 9. Excess-3 code is basically 4-bit binary code which can be obtained by adding 3 to each binary, that is Excess-3 code are valid from 3 to 15.Excess-3 code is Non-Weighted code.Excess-3 code is also called as *sequential code or self-complementary code.*

PIN DIAGRAM:



PROCEDURE :

1. Make the connections as per the Logic circuit of 4-bit Binary to 4-bit Gary Code converter and Vice-versa and Verify its Truth Table.
2. Make the connections as per the Logic circuit of 4-bit BCD to 4-bit Excess-3 Code converter and Vice-versa and Verify its Truth Table

Design of 4-bit Binary to Gray code converter

INPUT (BINARY CODE)				**OUTPUT (GRAY CODE)**			
B_3	B_2	B_3	B_2	B_3	B_2	B_3	B_2
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	1
0	1	0	1	0	1	0	1

1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0
1	0	1	0	1	0	1	0
1	1	1	1	1	1	1	1
1	1	1	1	1	1	1	1
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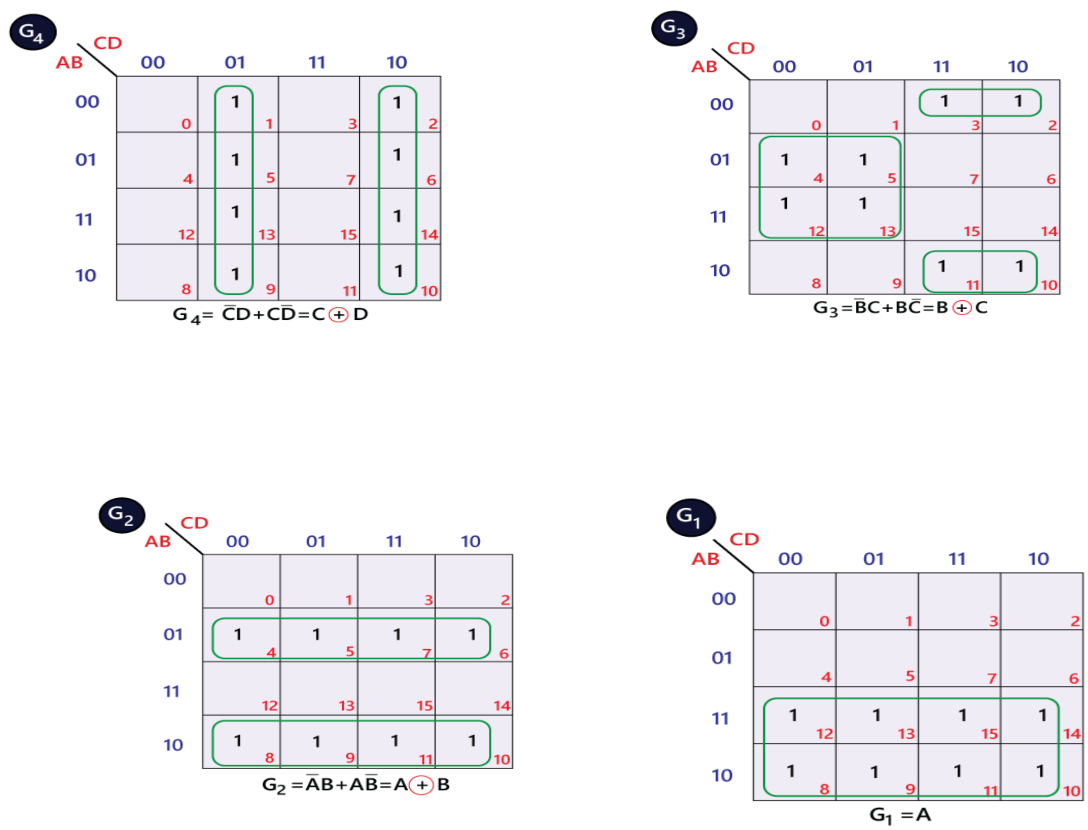
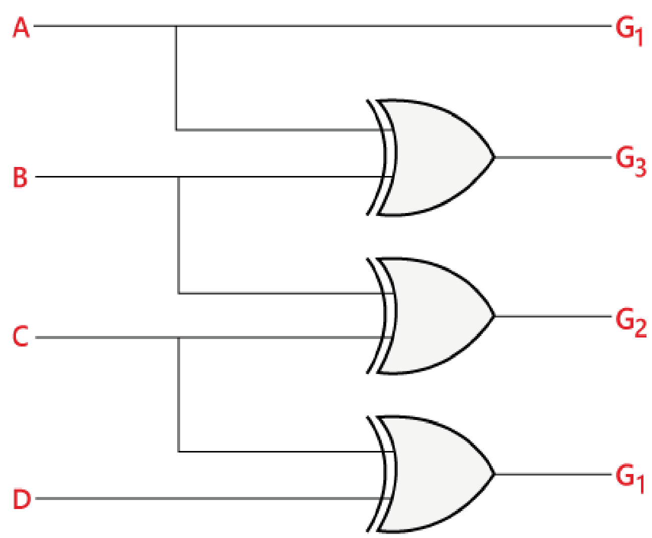
K-Map Simplification for G3, G2, G1, Go



Logic Diagram:



Logic Circuit for Binary to Gray Code Converter

Design of 4-bit Gray to Binary code converter

INPUT (GRAY CODE)				OUTPUT (BINARY CODE)			
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 Simplification for B3, B2, B1, Bo

1) K-Map for Reduced Boolean Expressions of Each Output:

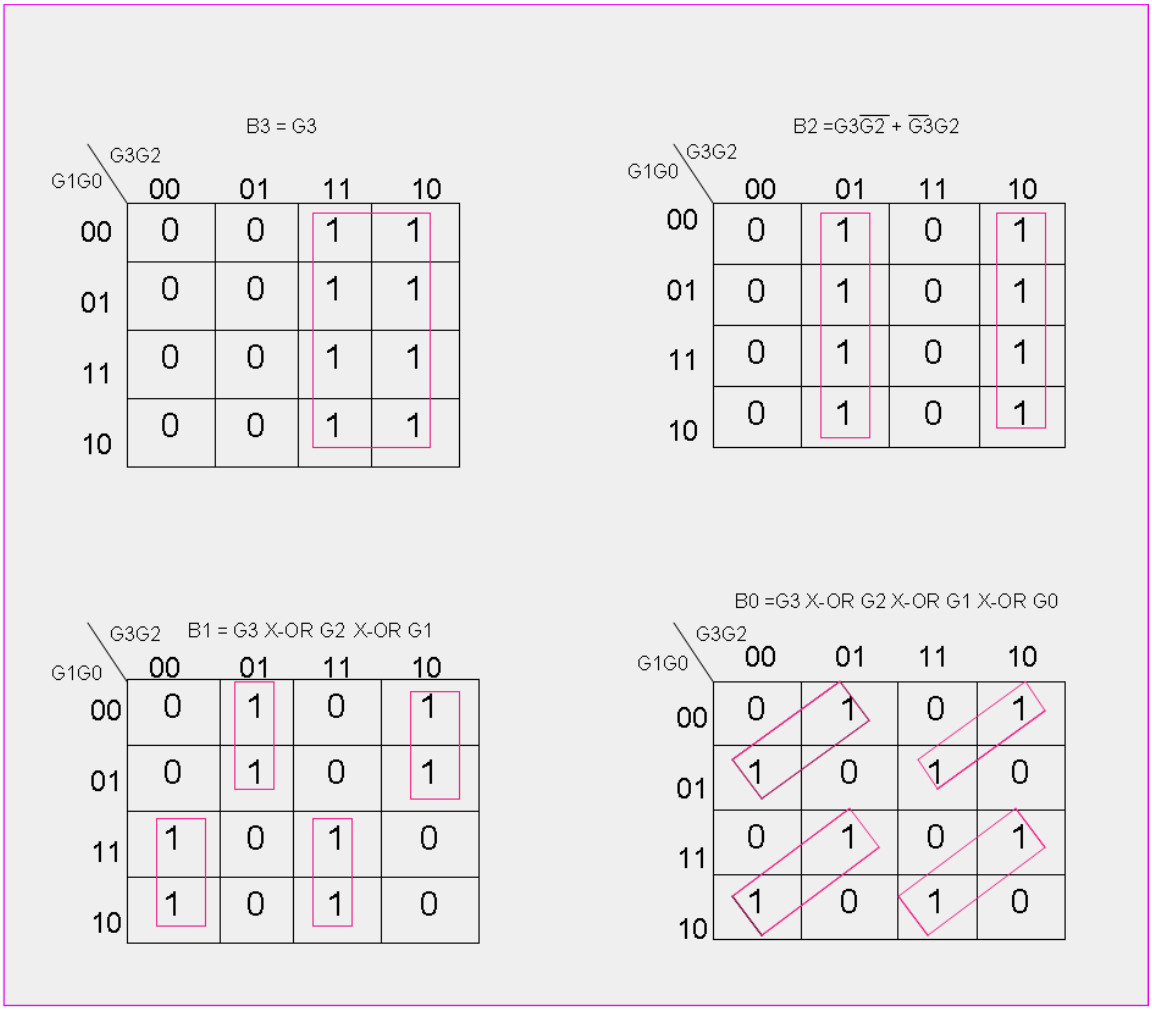
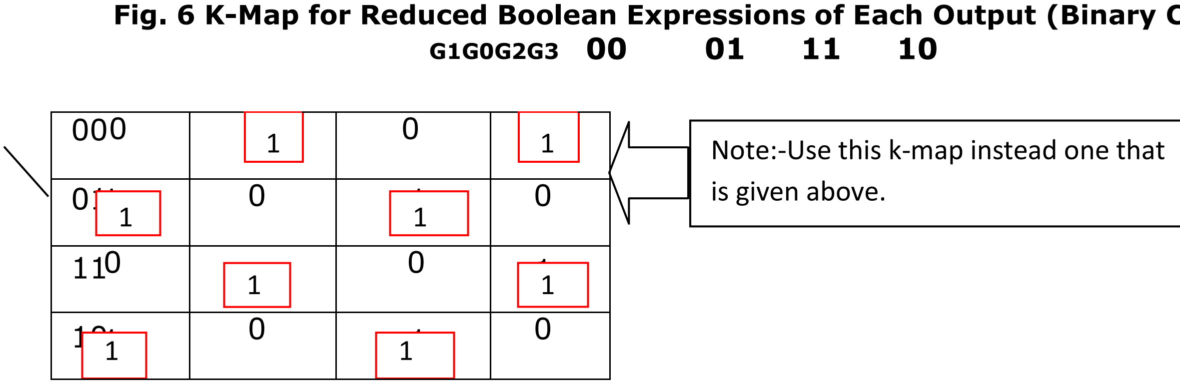
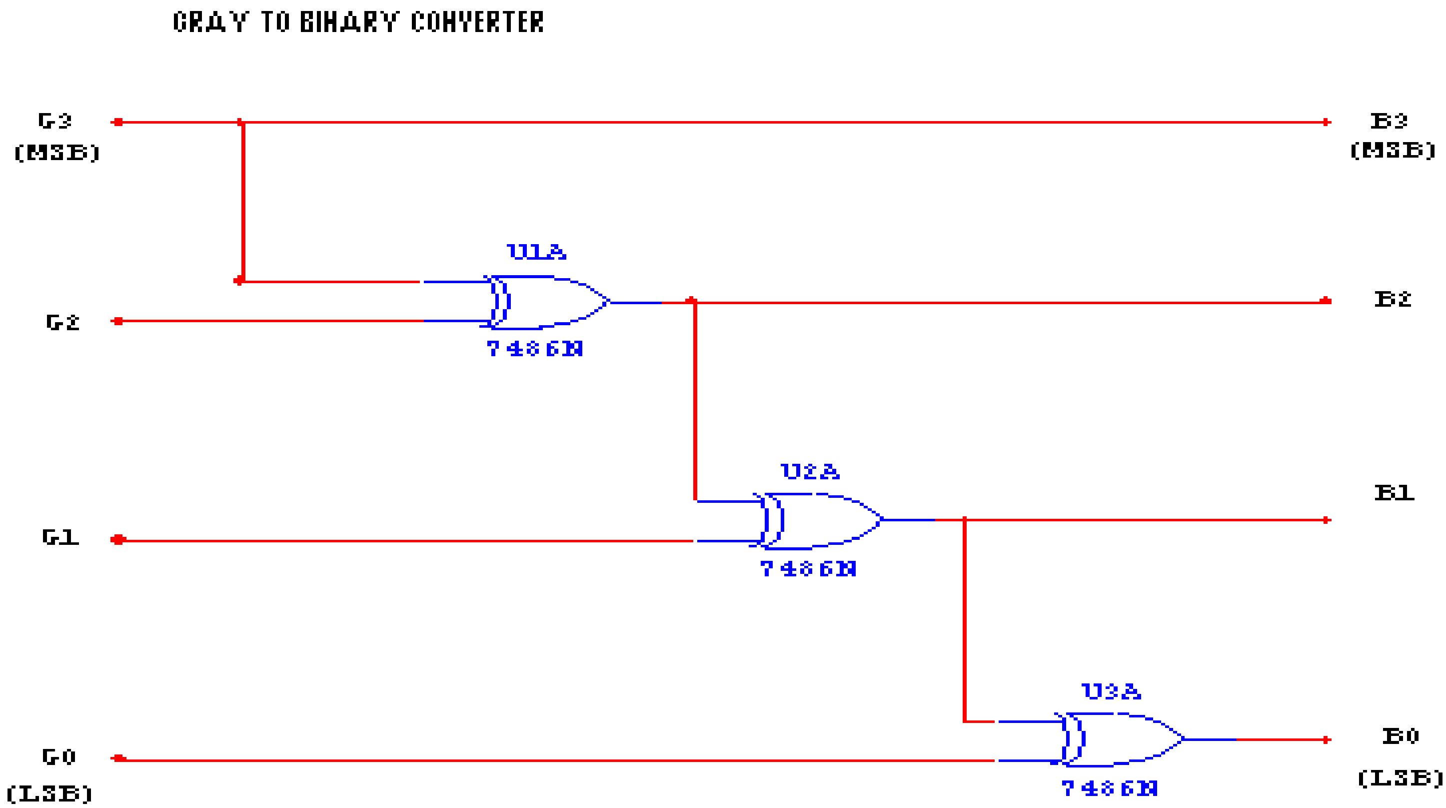


Fig. 6 K-Map for Reduced Boolean Expressions of Each Output (Binary Code)



B0 = G3 X-OR G2 X-OR G1 X-OR G0

Logic Diagram:



Design of BCD code to Excess-3Code converter

1) Truth Table:

Table 3 BCD to Excess-3 Code Conversion

INPUT (BCD CODE)				OUTPUT (EXCESS-3 CODE)			
B_3	B_2	B_1	B_0	E_3	E_2	E_1	E_0
0	0	0	0	0	0	1	1
0	0	0	1	0	1	0	0
0	0	1	0	0	1	0	1
0	0	1	1	0	1	1	0
0	1	0	0	0	1	1	1
0	1	0	1	1	0	0	0
0	1	1	0	1	0	0	1
0	1	1	1	1	0	1	0
1	0	0	0	1	0	1	1
1	0	0	1	1	1	0	0
1	0	1	0	x	x	x	x
1	0	1	1	x	x	x	x
1	1	0	0	x	x	x	x
1	1	0	1	x	x	x	x
1	1	1	0	x	x	x	x
1	1	1	1	x	x	x	x

2) K-Map for Reduced Boolean Expressions of Each Output:

Fig. 8 K-Map for Reduced Boolean Expressions Of Each Output (Excess-3 Code)

$E3 = B3 + B2(B1 + B0)$

B1B0 \ B3B2	00	01	11	10
00	0	0	X	1
01	0	1	X	1
11	0	1	X	X
10	0	1	X	X

$E2 = \overline{B2}(B1 + B0) + B2\overline{B1}\overline{B0}$

B1B0 \ B3B2	00	01	11	10
00	0	1	X	0
01	1	0	X	1
11	1	0	X	X
10	1	0	X	X

$E1 = B1B0 + \overline{B1}\overline{B0}$

B1B0 \ B3B2	00	01	11	10
00	1	1	X	1
01	0	0	X	0
11	1	1	X	X
10	0	0	X	X

$E0 = \overline{B0}$

B1B0 \ B3B2	00	01	11	10
00	1	1	X	1
01	0	0	X	0
11	0	0	X	X
10	1	1	X	X

3) Circuit Diagram:

BCD TO EXCESS-3 CONVERTER

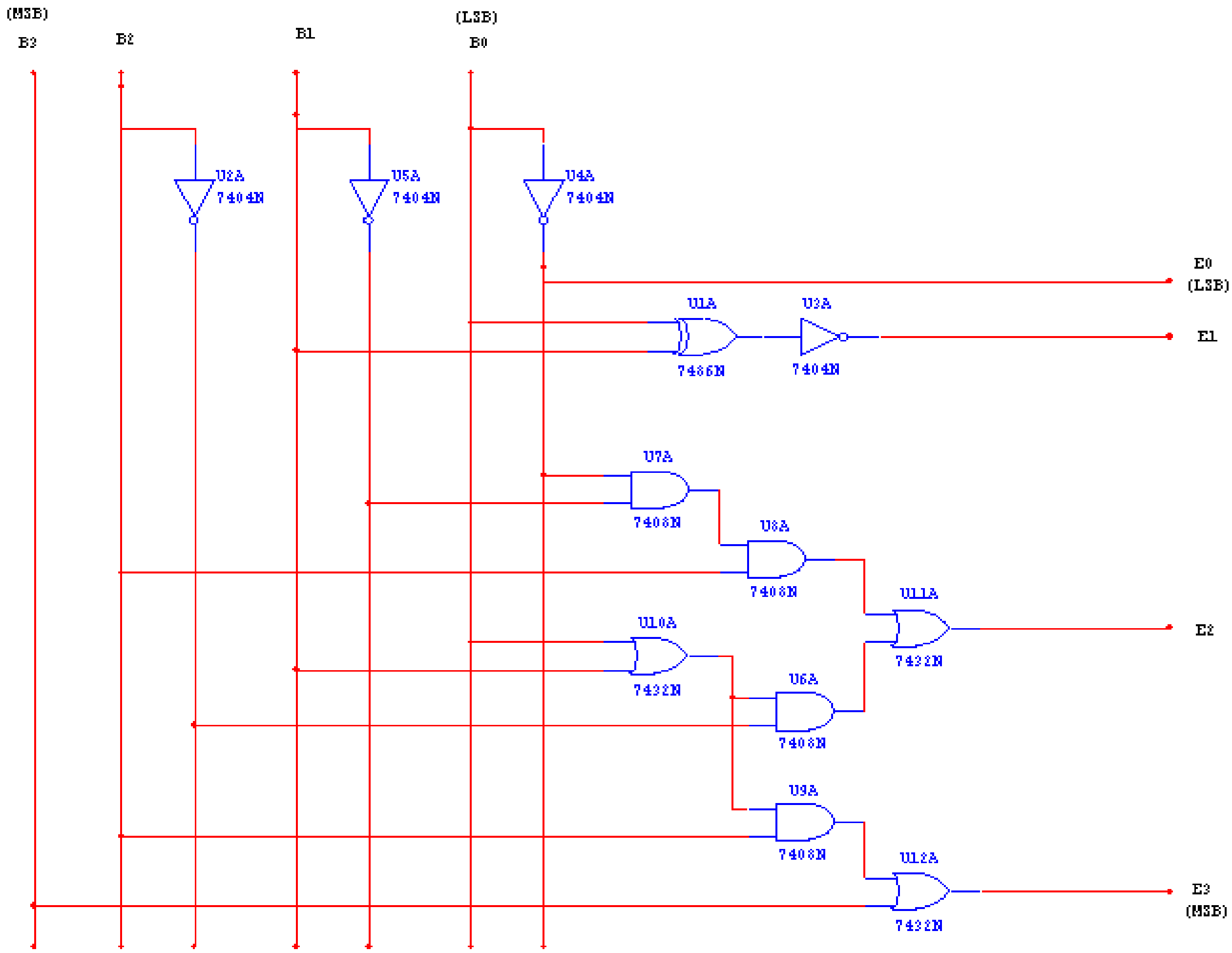


Fig.9 Logical Circuit Diagram for BCD to Excess-3 Code Conversion

OUTCOME

Thus, we studied different codes and their conversions including applications. The truth tables have been verified using IC 7486, 7432, 7408, and 7404.

FAQ's with answers:

Q.1) What is the need of code converters?

There is a wide variety of binary codes used in digital systems. Often it is required to convert from one code to another. For example the input to a digital system may be in natural BCD and output may be 7- segment LEDs. The digital system used may be capable of processing the data in straight binary format. Therefore, the data has to be converted from one type of code to another type for different purpose.

Q.2) What is Gray code?

It is a modified binary code in which a decimal number is represented in binary form in such a way that each Gray- Code number differs from the preceding and the succeeding number by a single bit.

(e.g. for decimal number 5 the equivalent Gray code is 0111 and for 6 it is 0101. These two codes differ by only one-bit position i. e. third from the left.) It is non-weighted code.

Q.3) What is the significance of Gray code?

Important feature of Gray code is it exhibits only a single bit change from one code word to the next in sequence. Whereas by using binary code there is a possibility of change of all bits if we move from one number to other in sequence (e.g. binary code for 7 is 0111 and for 8 it is 1000). Therefore, it is more useful to use Gray code in some applications than binary code.

Q.4) What are applications of Gray code?

1. Important feature of Gray code is it exhibits only a single bit change from one code word to the next in sequence. This property is important in many applications such as Shaft encoders where error susceptibility increases with number of bit changes between adjacent numbers in sequence.

2. It is sometimes convenient to use the Gray code to represent the digital data converted from the analog data (Outputs of ADC).

3. Gray codes are used in angle-measuring devices in preference to straight forward binary encoding.

4. Gray codes are widely used in K-map

Q.5) What are weighted codes and non-weighted codes?

In weighted codes each digit position of number represents a specific weight. The codes 8421, 2421, and 5211 are weighted codes.

Non weighted codes are not assigned with any weight to each digit position i.e. each digit position within the number is not assigned a fixed value. Gray code, Excess-3 code are non-weighted code.

Q.6) Why is Excess-3 code called as self-complementing code?

Excess-3 code is called self-complementing code because 9‛s complement of a coded number can be obtained by just complementing each bit.

Q.7) What is invalid BCD?

With four bits, sixteen numbers (0000 to 1111) can be represented, but in BCD code only 10 of these are used as decimal numbers have only 10 digits fro 0 to 9. The six code combinations (1010 to 1111) are not used and are invalid.

REFERENCE:

1. R.P. Jain "Modern Digital Electronics" TMH 4th Edition
2. D.Leach, Malvino, Saha, "Digital Principles and Applications", TMH