Topic: Code conversions

What is meant by code?

The digital data is represented, stored and transmitted as group of binary bits. This group is also called as binary code. The binary code is represented by the number as well as alphanumeric letter.

Codes are classified in to 2 types

- Weighted
- Non-weighted

WEIGHTED CODE

- In weighted code, each digit position has a weight or value.
- The sum of all digits multiplied by a weight gives a total amount being represented.
- BCD or 8421 is a type of weighted code where each digit position is assigned a specific weight.

NON WEIGHTED CODE

- In non weighted code there is no positional weight
- i.e., Each position within the binary number is not assigned a prefix value.
- No specific positions are assigned to bit positions in non weighted code.
- The non weighted codes are (1) Gray code
  (2) Excess-3 code.

Code converters

Code conversion is used to change the data present in one type of binary code to another type of binary code. Some of the codes are BCD, Gray, Excess 3, ASCII and so on.

Some of the conversions are

- Binary to Gray code conversion
- Gray to Binary code conversion
- BCD to Excess-3 code conversion
- Excess-3 to BCD code conversion

Binary to Gray code conversion

The Gray code is non-weighted code, as the position of bit does not contain any weight. The Gray code is a reflective digital code which has the special property that any two subsequent numbers codes differ by only one bit. This is also called a unit- distance code.

The generation of 4-bit Gray code can be calculated by using formula.

$$G_1 = B_1$$
$$G_2 = B_1 \oplus B_2$$
$$G_3 = B_2 \oplus B_3$$
$$G_4 = B_3 \oplus B_4$$

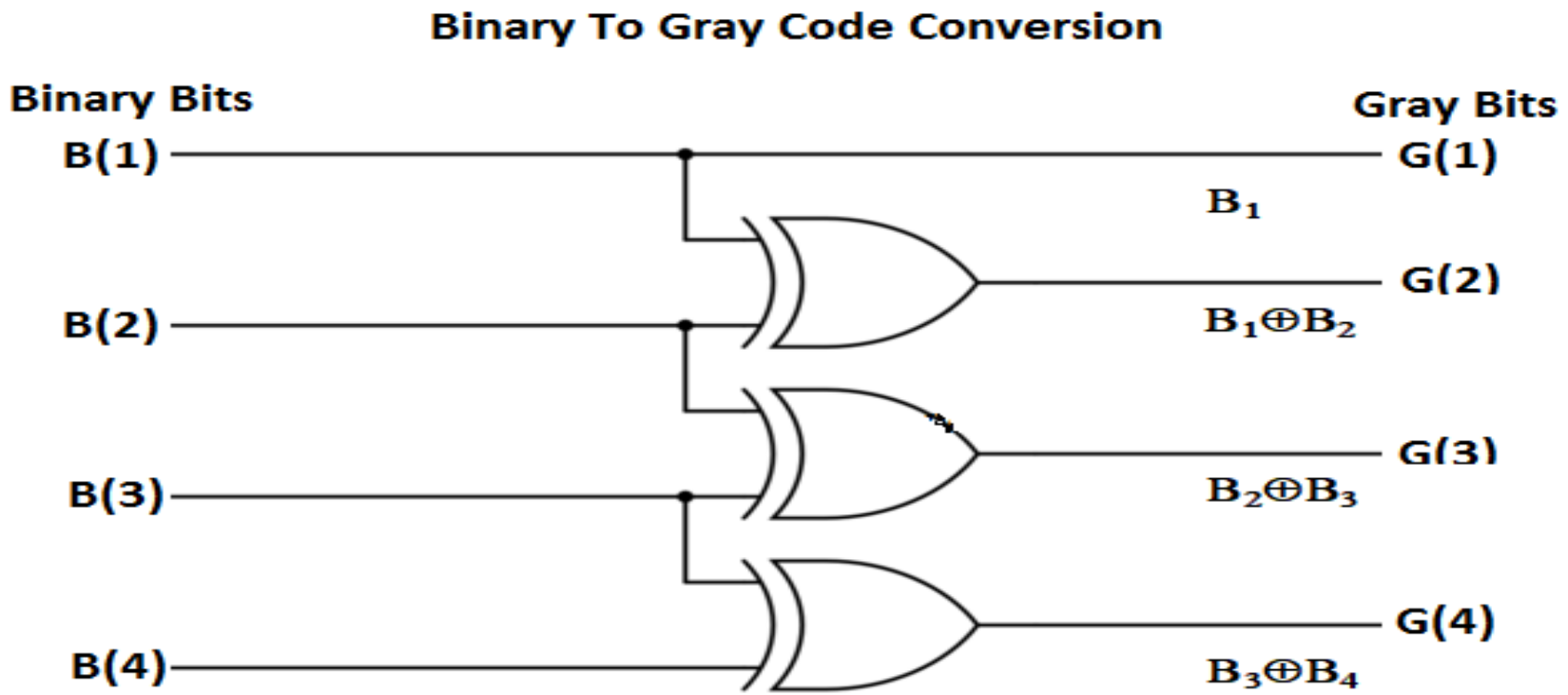
The most significant bit (MSB) of the Gray code is always equal to the MSB of the given binary code other bits of the output Gray code can be obtained by Xoring binary code bit at that index and previous index.

The binary to Gray code conversions can be done by using xoring logic gate. A four-bit binary code converter is shown above. The input is binary code and the output is equivalent Gray code.

A four-bit binary to Gray code conversion table is as shown below.

Four Bit Binary Number				Four Bit Gray Code			
B_1	B_2	B_3	B_4	G_1	G_2	G_3	G_4
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
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

The circuit for Binary to Gray code conversion is



Gray to binary code conversion

In Gray to binary conversion, the input is Gray code and output is its equivalent binary code.

The generation of four-bit binary equivalent code can be calculated by using formula.

$$B_1 = G_1$$

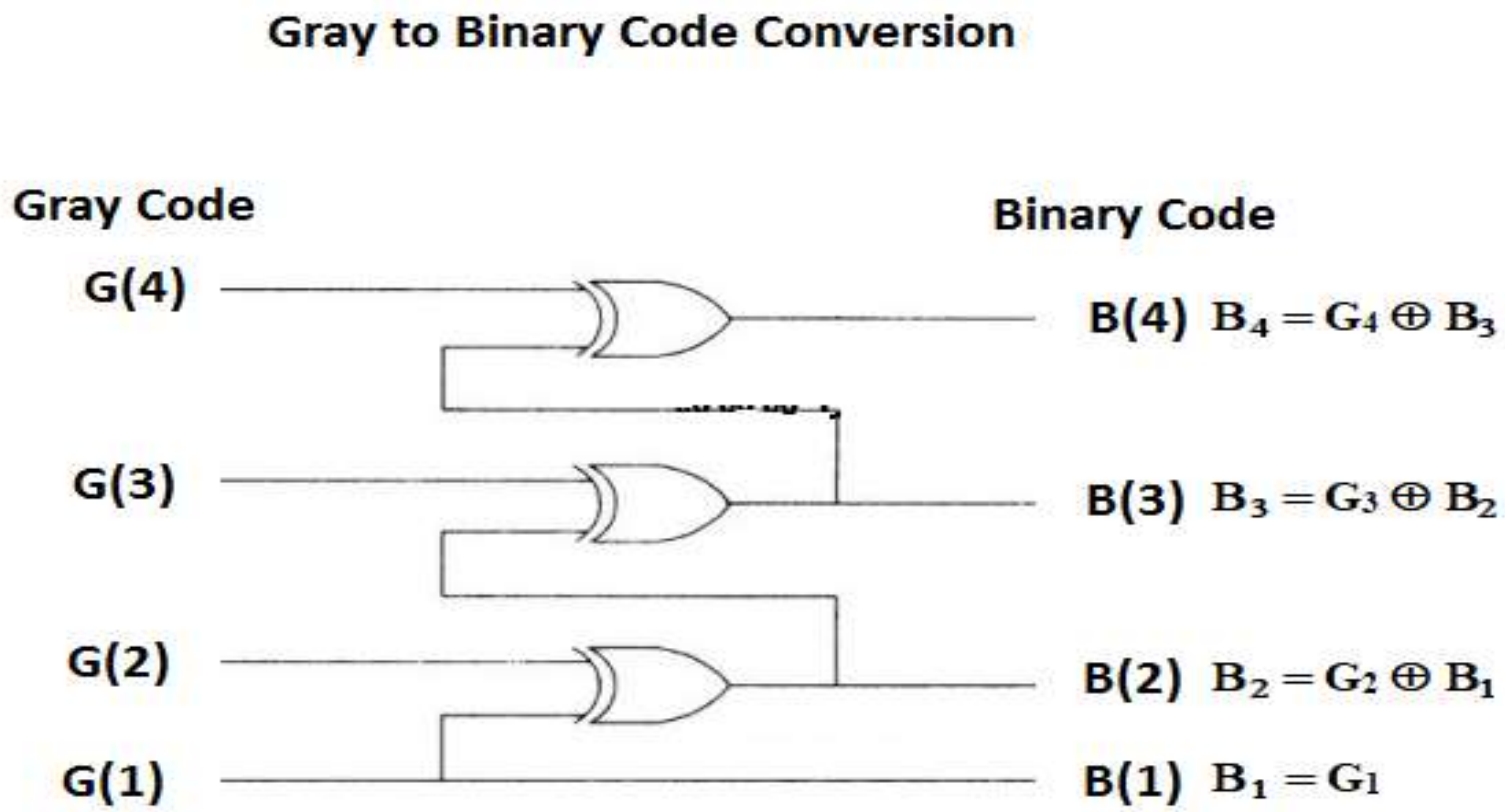
$$B_2 = G_2 \oplus B_1$$

$$B_3 = G_3 \oplus B_2$$

$$B_4 = G_4 \oplus B_3$$

- The MSB of binary code is similar to the MSB of Gray code.
- To get next bit, use the xoring operation among the MSB of binary to the next bit of the Gray code.
- Similarly, to get the third bit, it uses the xoring operation among the second bit to the third MSB of the Gray code and so on.

- The Gray to binary conversion method can be done by using xoring logic gate.
- A four-bit Gray to binary code converter is as shown below.



A four-bit Gray to binary code conversion table is as shown below.

Four Bit Gray Code				Four Bit Binary Number			
G_1	G_2	G_3	G_4	B_1	B_2	B_3	B_4
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

BCD to Excess 3 code

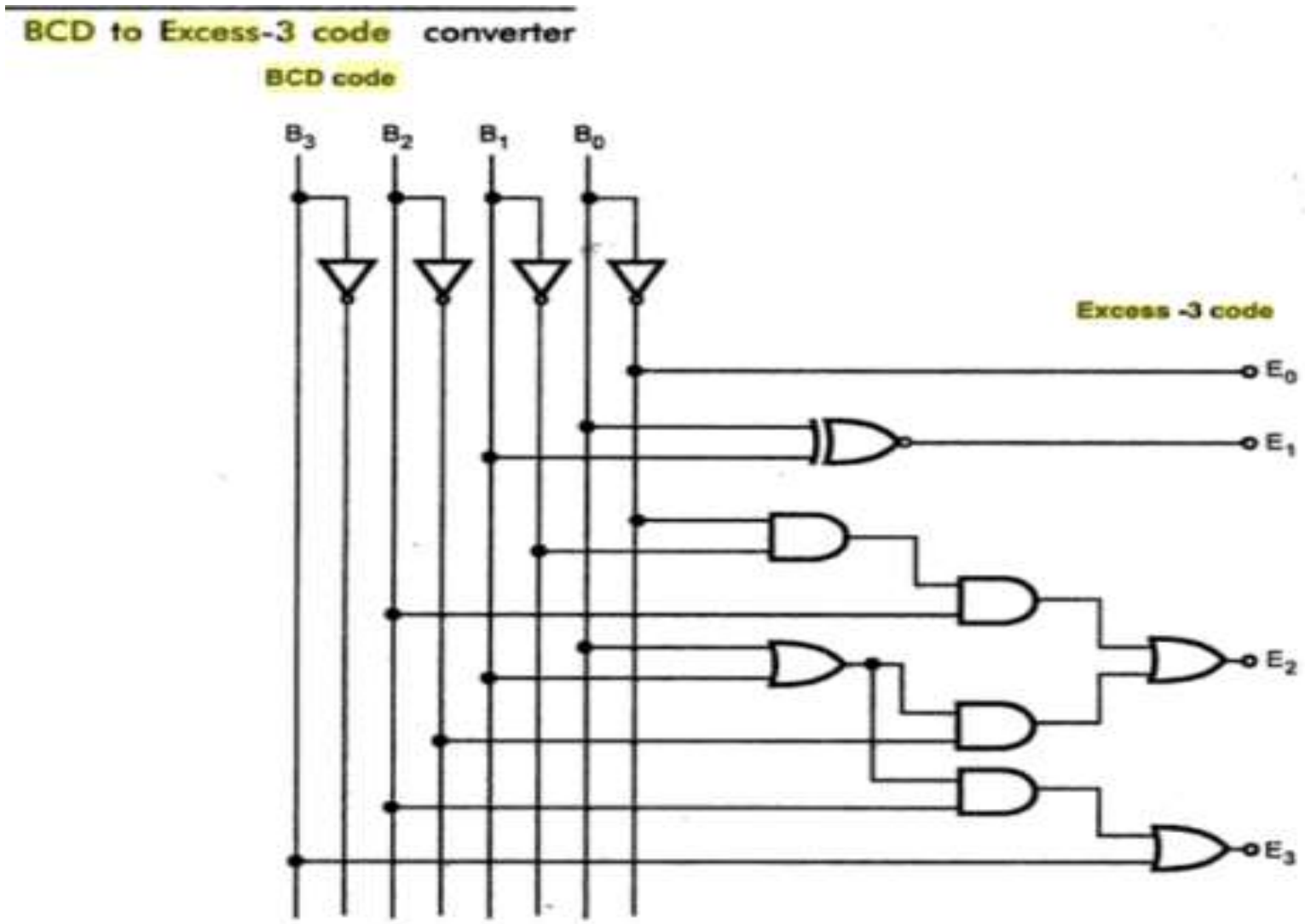
- Excess-3 codes are unweighted and can be obtained by adding 3 to each decimal digit then it can be represented by using 4-bit binary number for each digit.
- To find the decimal equivalent of the given binary number. Add 0011 to each four-bit group in binary coded decimal number (BCD) to get desired excess-3 equivalent.
- The variables B_0, B_1, B_2, and B_3 represent the bits of the binary numbers.
- The variable 'B_0' represents the LSB, and the variable 'B_3' represents the MSB.
- The variables E_0, E_1, E_2, and E_3 represent the bits of the Excess-3 code.
- The variable 'E_0' represents the LSB, and the variable 'E_3' represents the MSB.

The truth table for BCD to Excess-3 code converter can be determined as shown in table below.

For impossible four bit Excess-3 code we use output as Don’t care conditions. The 'don't care conditions' is defined by the variable 'X'.

	BCD Number				Excess-3 Code Number			
Decimal	B_3	B_2	B_1	B_0	E_3	E_2	E_1	E_0
0	0	0	0	0	0	0	1	1
1	0	0	0	1	0	1	0	0
2	0	0	1	0	0	1	0	1
3	0	0	1	1	0	1	1	0
4	0	1	0	0	0	1	1	1
5	0	1	0	1	1	0	0	0
6	0	1	1	0	1	0	0	1
7	0	1	1	1	1	0	1	0
8	1	0	0	0	1	0	1	1
9	1	0	0	1	1	1	0	0

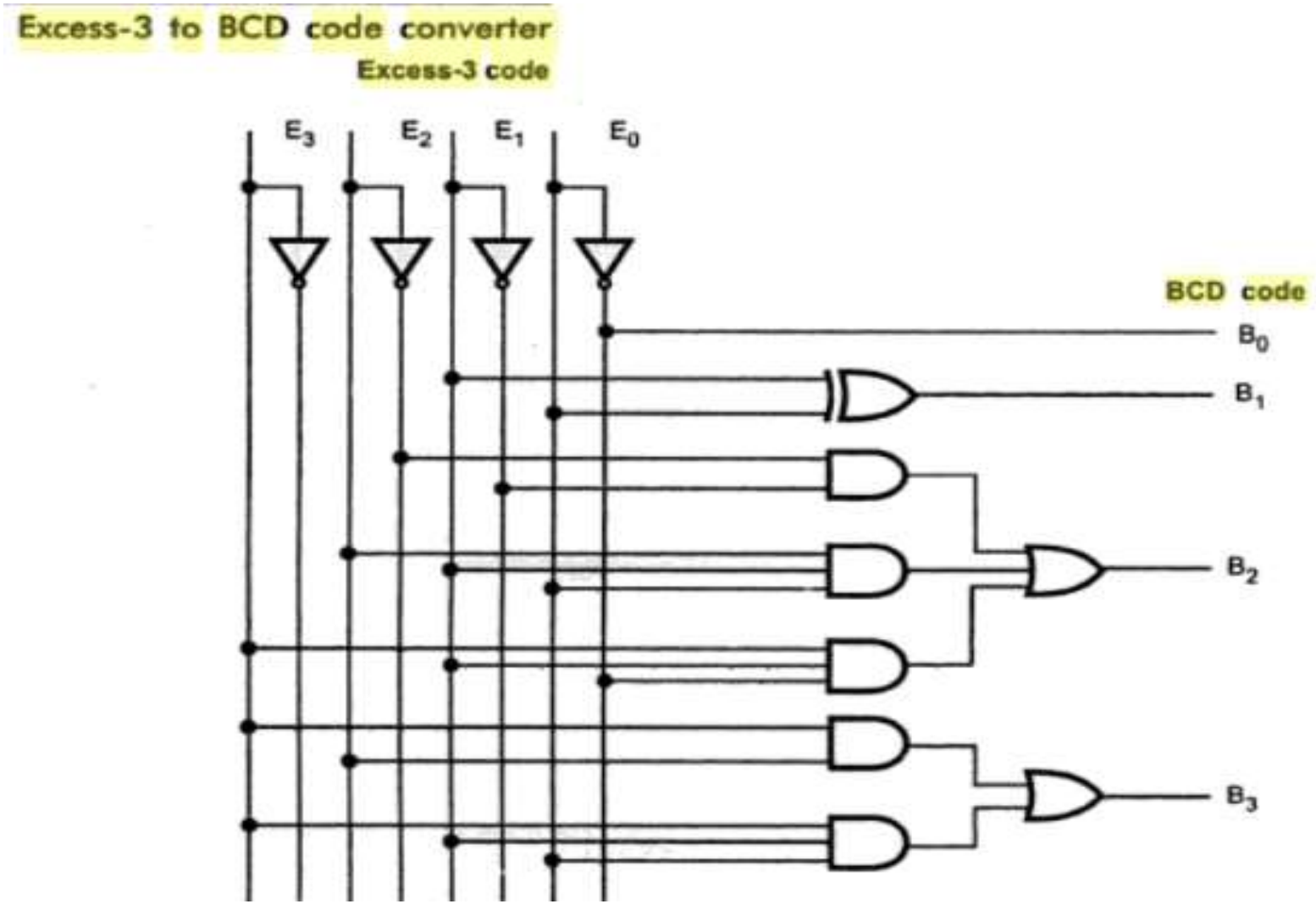
The circuit diagram for BCD to Excess-3 code converter is shown below



Excess-3 to BCD converter

- The process of converting Excess-3 to BCD is opposite to the process of converting BCD to Excess-3.
- The BCD code can be calculated by subtracting 3, i.e., 0011 from each four-digit Excess-3 code.
- The variables E_0, E_1, E_2, and E_3 represent the bits of the Excess-3 code.
- The variable 'E_0' represents the LSB, and the variable 'E_3' represents the MSB.
- The variables B_0, B_1, B_2, and B_3 represent the bits of the binary numbers.
- The variable 'B_0' represents the LSB, and the variable 'B_3' represents the MSB.
- The 'don't care conditions' is defined by the variable 'X'.

The circuit diagram for Excess-3 code to BCD converter is shown below



The truth table for BCD to Excess-3 code converter can be determined as shown in table below.

	Excess-3 Code Number				BCD Number			
Decimal	E_3	E_2	E_1	E_0	B_3	B_2	B_1	B_0
0	0	0	1	1	0	0	0	0
1	0	1	0	0	0	0	0	1
2	0	1	0	1	0	0	1	0
3	0	1	1	0	0	0	1	1
4	0	1	1	1	0	1	0	0
5	1	0	0	0	0	1	0	1
6	1	0	0	1	0	1	1	0
7	1	0	1	0	0	1	1	1
8	1	0	1	1	1	0	0	0
9	1	1	0	0	1	0	0	1

Prepared by
B. SRIKANTH

Lr. In Physics/Electronics
P.R.Government College(A)
Kakinada