Experiment - 3

Aim: To design a circuit to convert 4 bit binary code to 4 bit gray code.

Component required: XOR Gates, wires, IC 4070, Digital trainer kit

Theory: The reflected binary code (RBC), also know as reflected binary (RB) or gray code after Frank Gray, in an ordering of the binary numeral system such that two successive values differ in only one bit.

For example the representation of the decimal value '1' in binary would be '001' and '0' would be "010". In Gray code, these values are represented as '001' and '011'. That way incremenation of value from 1 to 2 requires one bit to change instead of 2.

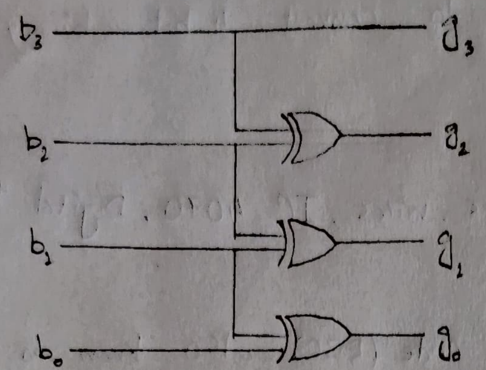
Convert the binary into gray code:

1. In the Gray code, the MSB will always be the same as the 1^{st} bit of the given binary number.

2. In order to perform the 2^{nd} bit of the Gray code, we perform the XOR of the 1^{st} bit and 2^{nd} bit of the binary number. It means that if both the bits are different, the result will be one or else the result will be 0.

3. In order to get the 3^{rd} bit of the gray code, we need to perform the XOR of the 2^{nd} and 3^{rd} bit of the binary number. This process remains the same for the 4^{th} bit of the gray code.

Circuit Diagram:



$g_3 = b_3$

$g_2 = b_3 \oplus b_2$

$g_1 = b_2 \oplus b_1$

$g_0 = b_1 \oplus b_0$

Here, b_3, b_2, b_1, b_0 are the binary codes where as g_3, g_2, g_1 and g_0 as gray code.

Truth Table:

	Binary Input				Gray Output			
Decimal	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	0	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

Result: Thus with a simple logic circuit we can convert any binary into gray code.

Experiment No. - 4

Aim: To design a circuit to convert 4 bit gray code to 4 bit binary.

Components Required: XOR gates, wires, IC 4070, Digital Trainer kit

Theory: Binary is scheme of number that only has two possible values for each digit 0 and 1. The digital world is represented in binary, but hexadecimal, which is compatible with binary and more easily understood by people, in commonly used like ~~prev~~ previously mentioned binary uses only the numbers 0 and 1. However in some cases L/H is used as a counter part to 0/1 notation.

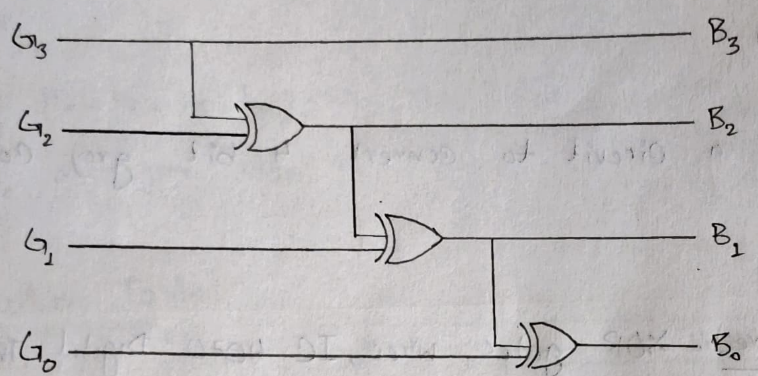
Convert the gray code into binary -

- Just like binary to gray, in gray to binary, the 1st bit of the binary number is similar to the MSB of the gray code.
- The 2nd bit of the binary number is the same as the 1st bit of the binary number when the 2nd bit of the gray code is 0, otherwise the 2nd bit is altered bit of the 1st bit of binary

number. It means if the 1st bit of the binary is 1, then the 2nd bit is 0, and if it is 0 the the 2nd bit be 1.

- The 2nd step continues for all bits of the binary number.

Circuit Diagram:



$b_3 = g_3$

$b_2 = b_3 \oplus g_2$

$b_1 = b_2 \oplus g_1$

$b_0 = b_1 \oplus g_0$

Here b_3, b_2, b_1, b_0 are the binary and g_3, g_2, g_1, g_0 are the grey code.

Truth table:

Decimal	Gray 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
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	1	0	0	1	0	0	0
13	1	1	0	1	1	0	0	1
14	1	1	1	0	1	0	1	1
15	1	1	1	1	1	0	1	0

Result: Thus with a simple logic circuit we can convert any gray code into binary code.

Experiment - 5

Aim: Realisation of a circuit to show prime and non prime numbers (4-bit)

Component required: NOT gates, AND Gate, OR Gates, wire, Digital trainer kit

Theory:

A minterm is a boolean expression resulting in 1 for the output of a single cell, and 0s for all other cells in a k-map or truth table. If a minterm has single 1 and the remaining cell as 0s, it would appear to cover a minimum area of 1s. It is an expression consisting of all the input term in the truth table, for which the output is 1.

For example a_3, a_2, a_1, a_0 maybe minterm but not $a_3 \cdot a_1 \cdot a_0$ it does not contain all the input.

Expression:

After taking the minterms for all prime numbers between 0-15 the expression we get is -

$$a_3'\cdot a_2'\cdot a_1\cdot a_0 + a_3'\cdot a_2\cdot a_1'\cdot a_0 + a_3'\cdot a_2\cdot a_1\cdot a_0 + a_3\cdot a_2'\cdot a_1\cdot a_0 + a_3\cdot a_2\cdot a_1'\cdot a_0$$

Now we will simplify this expression using Boolean algebra.

Let, $a_3 = D$, $a_2 = C$, $a_1 = B$ and $a_0 = A$

$$P = a_3'\cdot a_2'\cdot a_1\cdot a_0 + a_3'\cdot a_2\cdot a_1'\cdot a_0 + a_3'\cdot a_2\cdot a_1\cdot a_0 + a_3\cdot a_2'\cdot a_1\cdot a_0 + a_3\cdot a_2\cdot a_1'\cdot a_0$$

$$= D'\cdot C'\cdot B\cdot A + D'\cdot C\cdot B'\cdot A + D'\cdot C\cdot B\cdot A + D\cdot C'\cdot B\cdot A + DCB'\cdot A$$

$$= D'\cdot C'\cdot B\cdot A + C\cdot B'\cdot A(D'+D) + D'\cdot C\cdot B\cdot A + D\cdot C'\cdot B\cdot A \quad [x+x'=1]$$

$$= D'\cdot C'\cdot B\cdot A + C\cdot B'\cdot A + D'\cdot C\cdot B\cdot A + D\cdot C'\cdot B\cdot A$$

$$= C'BA(D'+D) + CB'\cdot A + D'\cdot C\cdot B\cdot A \quad [x+x'=1]$$

$$= C'\cdot B\cdot A + C\cdot B'\cdot A + D'\cdot C B\cdot A$$

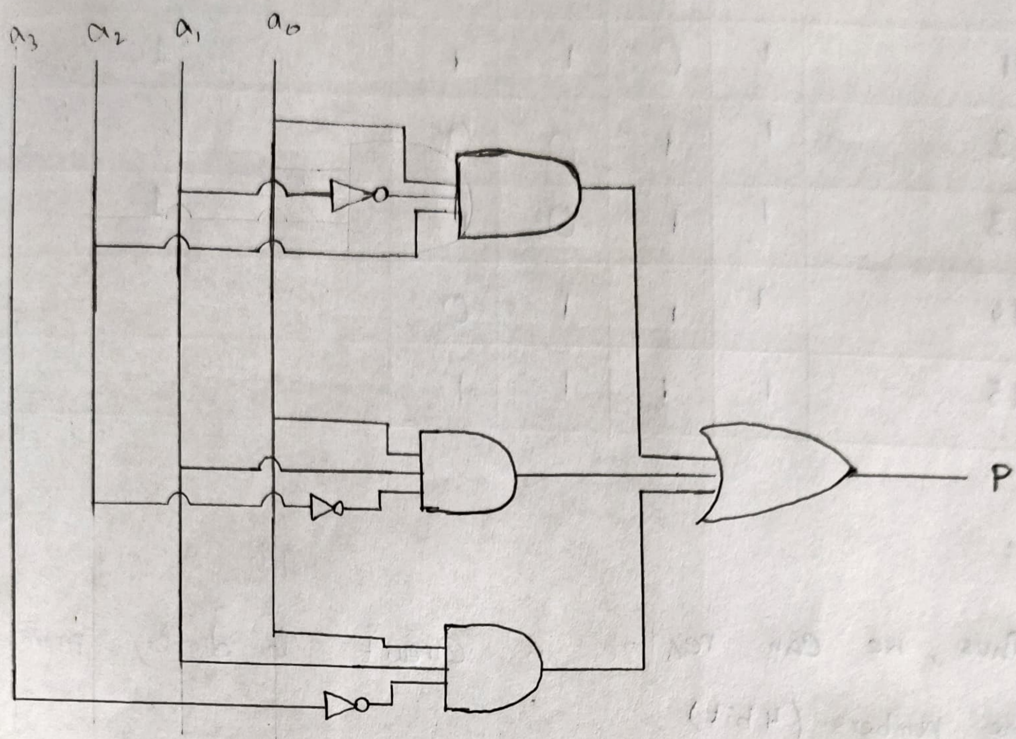
$$= C\cdot B'\cdot A + B\cdot A\cdot(C' + D'C) \quad [XY'+Y = X+Y]$$

$$= C\cdot B'\cdot A + B\cdot A\,(C' + D')$$

$$= C\cdot B'\cdot A + C'BA + D'BA$$

$$= a_2\cdot a_1'\cdot a_0 + a_2'\cdot a_1\cdot a_0 + a_3' a_1\cdot a_0$$

Circuit Diagram:



$P = a_2 \cdot a_1' \cdot a_0 + a_2' \cdot a_1 \cdot a_0 + a_3' \cdot a_1 \cdot a_0$

Truth Table:

Decimal	A_3	A_2	A_1	A_0	P
0	0	0	0	0	
1	0	0	0	1	
2	0	0	1	0	
3	0	0	1	1	1
4	0	1	0	0	
5	0	1	0	1	1
6	0	1	1	0	
7	0	1	1	1	1
8	1	0	0	0	

9	1	0	0	1	
10	1	0	1	0	
11	1	0	1	1	1
12	1	1	0	0	
13	1	1	0	1	1
14	1	1	1	0	
15	1	1	1	1	

Result:

Thus, we can realize a circuit to display prime and non-prime numbers (4 bit)