A Project report on

4 BIT BINARY CODE CONVERTER

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CERTIFICATE

This is to certify that *Syeda Muskaan (4NM21EC165)*, *T Gautham Poojary (4NM21EC166)*, *T Tushar Shenoy (4NM21EC167)*, *Tanvi N Shetty (4NM21EC168)* bonafide students of *N.M.A.M. Institute of Technology, Nitte* have submitted a project report entitled *"4 BIT BINARY CODE CONVERTER"* as part of the Project based Digital System Design Lab, in partial fulfillment of the requirements for the award of Bachelor of Engineering Degree in Electronics and Communication Engineering during the year 2022-2023.

Name of the Examiner   **Signature with date**

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ABSTRACT

The report discusses the conversions of various binary codes from one form to another.A code converter is a logic circuit that changes data presented in one type of binary code to another type of binary code, such as binary to gray code, gray code to binary, BCD to excess-3 code and excess-3 code to BCD.

The group of symbols is called as code. The digital data is represented, stored and transmitted as group of bits. This group of bits is also called as binary code. Binary codes can be classified into two types and they are weighted codes and non-weighted codes. If the code has positional weights, then it is said to be weighted code. Otherwise, it is an unweighted code. Weighted codes can be further classified as positively weighted codes and negatively weighted codes.

Coding is the process of translating the input information which can be understandable by the machine or a particular device. Coding can be used for security purpose to protect the information from steeling or interrupting. Code converters are used to convert the information into the desired code. These are basically encoders and decoders which converts the data into an encoded form. The four types of codes which are included in this project are Excess-3, BCD, Gray code and Binary.

TABLE OF CONTENTS

Chapter 1

INTRODUCTION

A 4-bit binary code converter is a circuit that can convert a 4-bit binary code represent from one form to another.

The excess-3 code (or XS3) is a non-weighted code used to express code used to express decimal numbers. It is a self-complementary binary coded decimal (BCD) 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.

BCD code or Binary coded Decimal codes. It is a numeric weighted binary codes, where every digit of a decimal number is expressed by a separate group of 4-bits. There are various BCD codes like 8421, 2421, 5211, etc. The BCD code is also known as the 8421 code.

Gray code is a non-weighted code. The successive gray code differs in one bit position only that means it is a unit distance code. It is also referred as cyclic code. It is not suitable for arithmetic operations. It is the most popular of the unit distance codes. It is also a reflective code.

Binary code in electronics refers to the representation of data and information using only two digits, 0 and 1. In digital electronics, binary codes are used to store, process and transmit information in computers and other digital devices. The binary system uses only two digits, 0 and 1, to represent all types of data, including numbers, letters, and special characters. The binary code is converted into electrical signals that can be processed and manipulated by electronic circuits. The binary system is a fundamental concept in digital electronics and forms the basis of modern computing.

Binary to Gray code conversion: The Binary to Gray code conversion involves converting a binary number into a gray code number. The gray code is a non-weighted code where only one bit changes between consecutive values. The conversion is performed by XORing the binary number with its right shift by 1 position.

BCD to Excess-3 conversion: BCD to Excess-3 conversion involves converting a BCD number into an Excess-3 number. In the Excess-3 code, the decimal equivalent of each code is 3 more than the BCD code. For example, if the BCD code is 1001, its Excess-3 code will be 1100.

Gray code to Binary conversion: The Gray code to Binary conversion involves converting a gray code number into its equivalent binary number. The conversion in general is performed by starting with the least significant bit (LSB) and XORing it with the previous bit. This process is repeated for each bit, starting from the LSB, to get the equivalent binary number.

Excess-3 to BCD conversion: The Excess-3 to BCD conversion involves converting an Excess-3 code into its equivalent BCD code. The conversion in general is performed by subtracting 3 from each digit in the Excess-3 code. For example, if the Excess-3 code is 0100, its BCD code will be 0001.

Chapter 2

DESIGN AND IMPLEMENTATION

A 4-bit binary code converter can be designed and implemented using different techniques such as hardware circuitry or software algorithms.

The Circuit is designed using multiplexer (MUX) and demultiplexer (DEMUX) along with Logic gates like OR, AND, NOT and XOR.
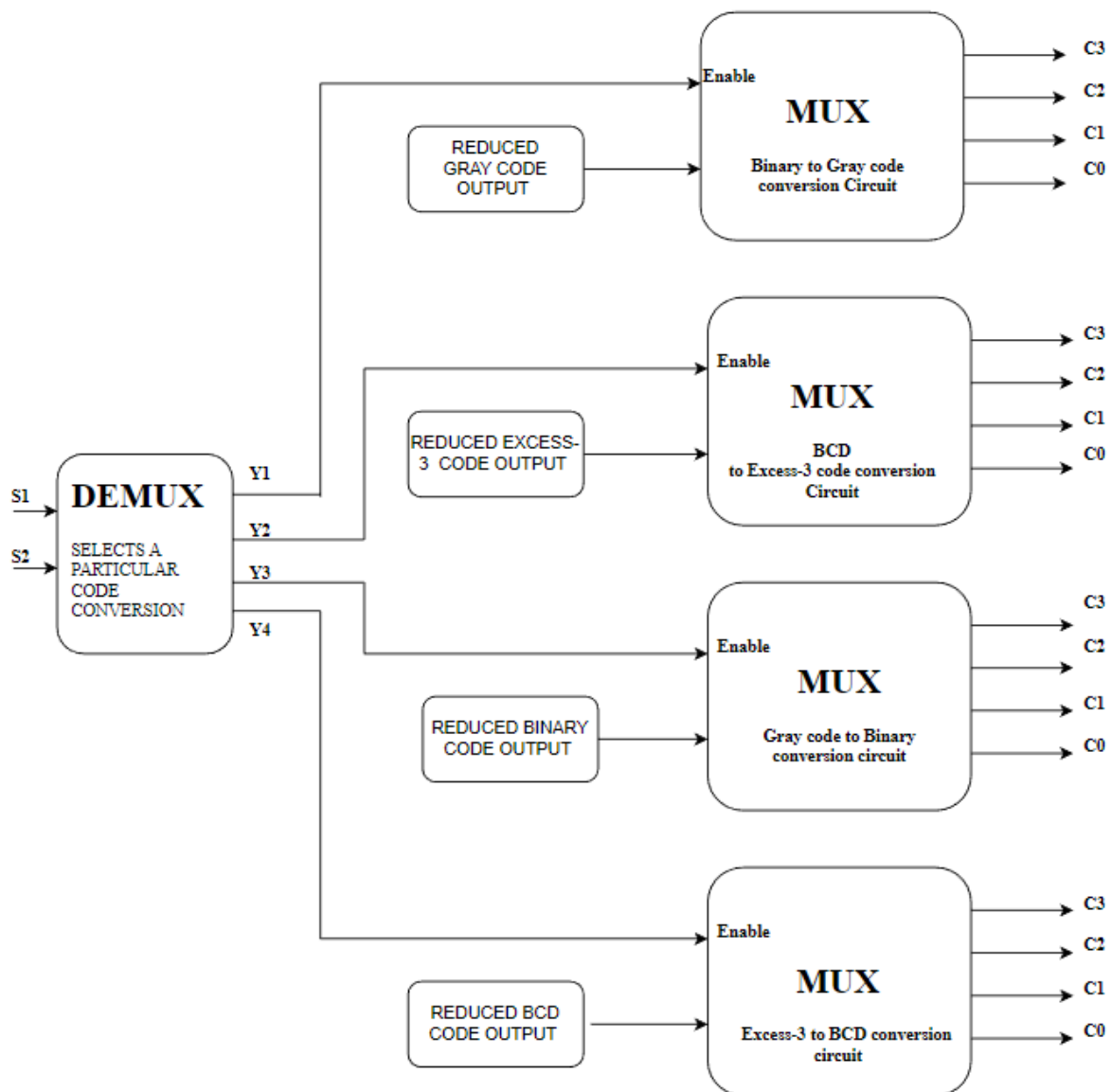
2.1 CIRCUIT DIAGRAM / BLOCK DIAGRAM
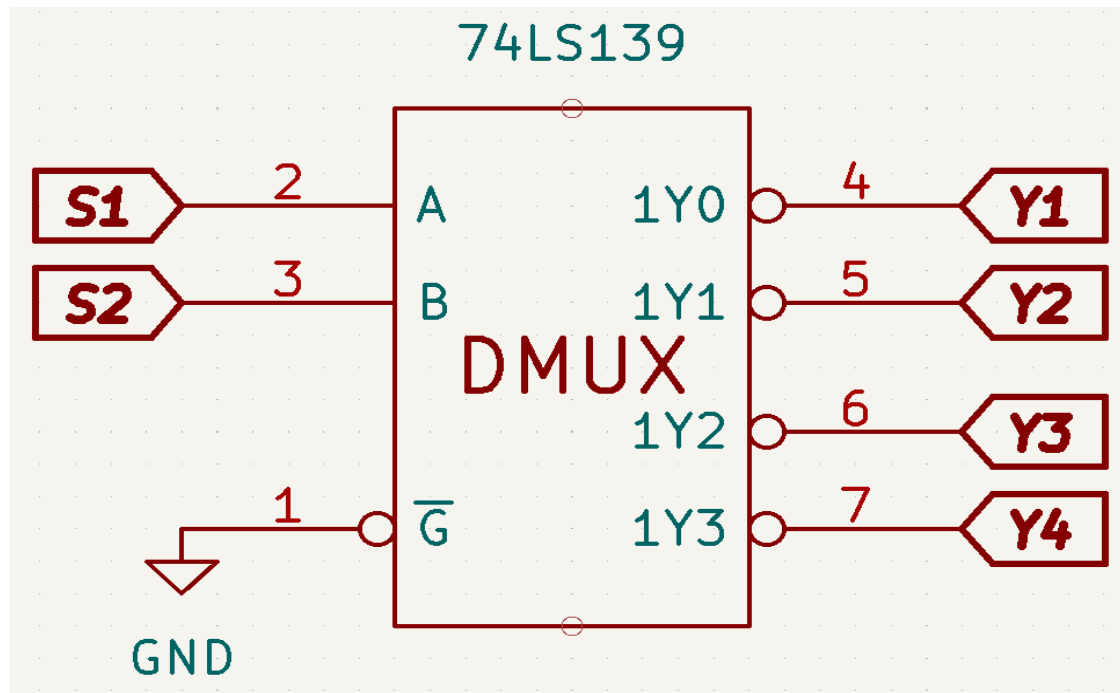

Figure 2.1.1Block diagram of the Code Converter Circuit

Figure 2.1.2 Demultiplexer Circuit

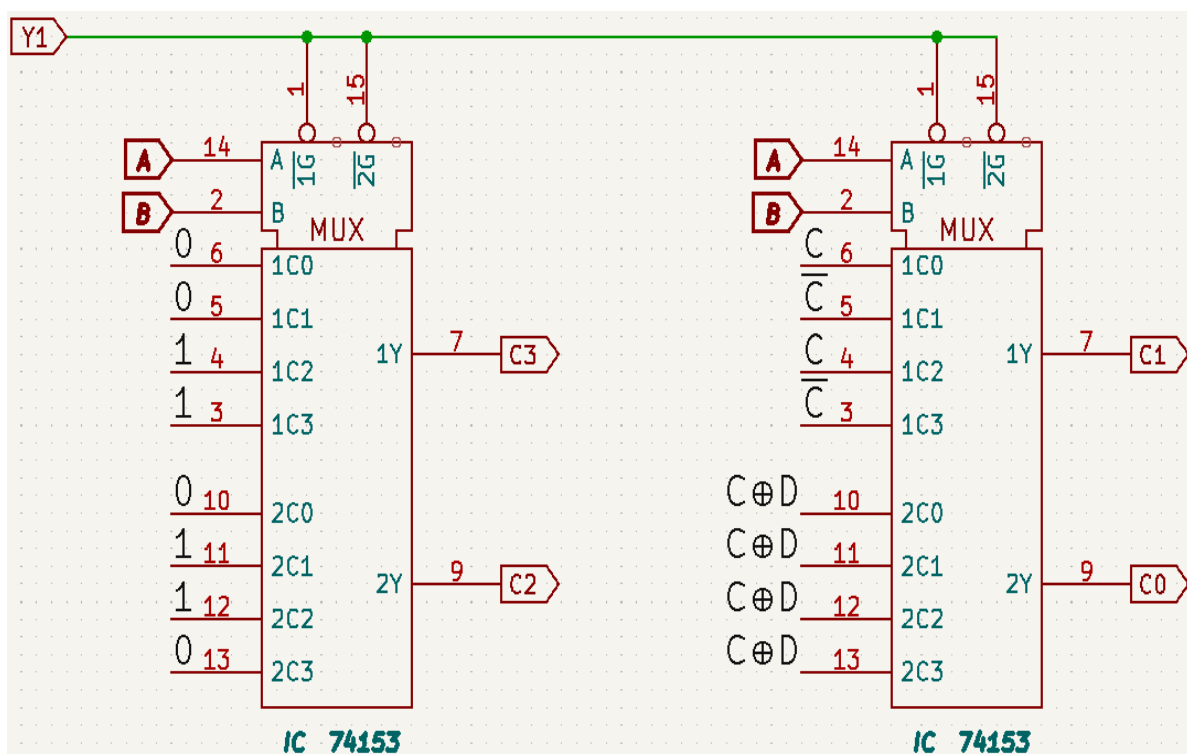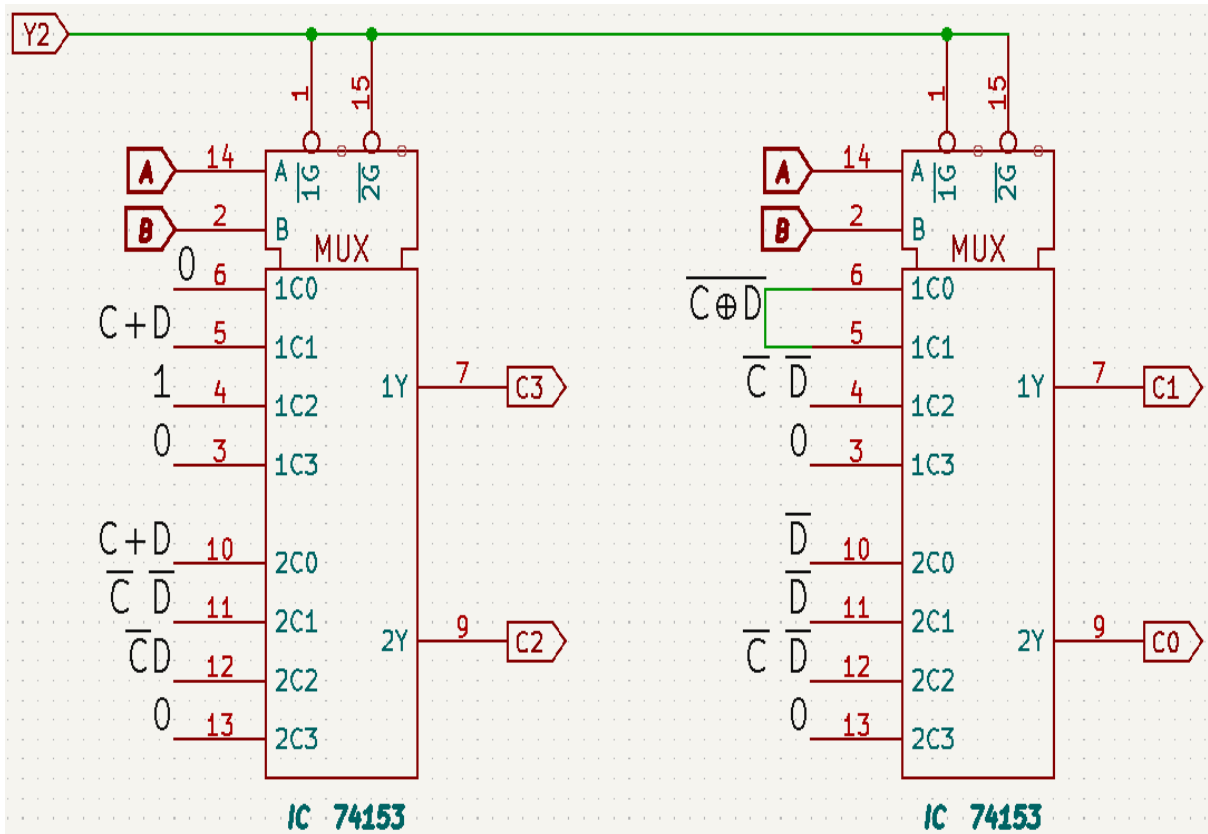**Figure 2.1.3 Binary to Gray code conversion Circuit**

Figure 2.1.4 BCD to Excess-3 code conversion Circuit

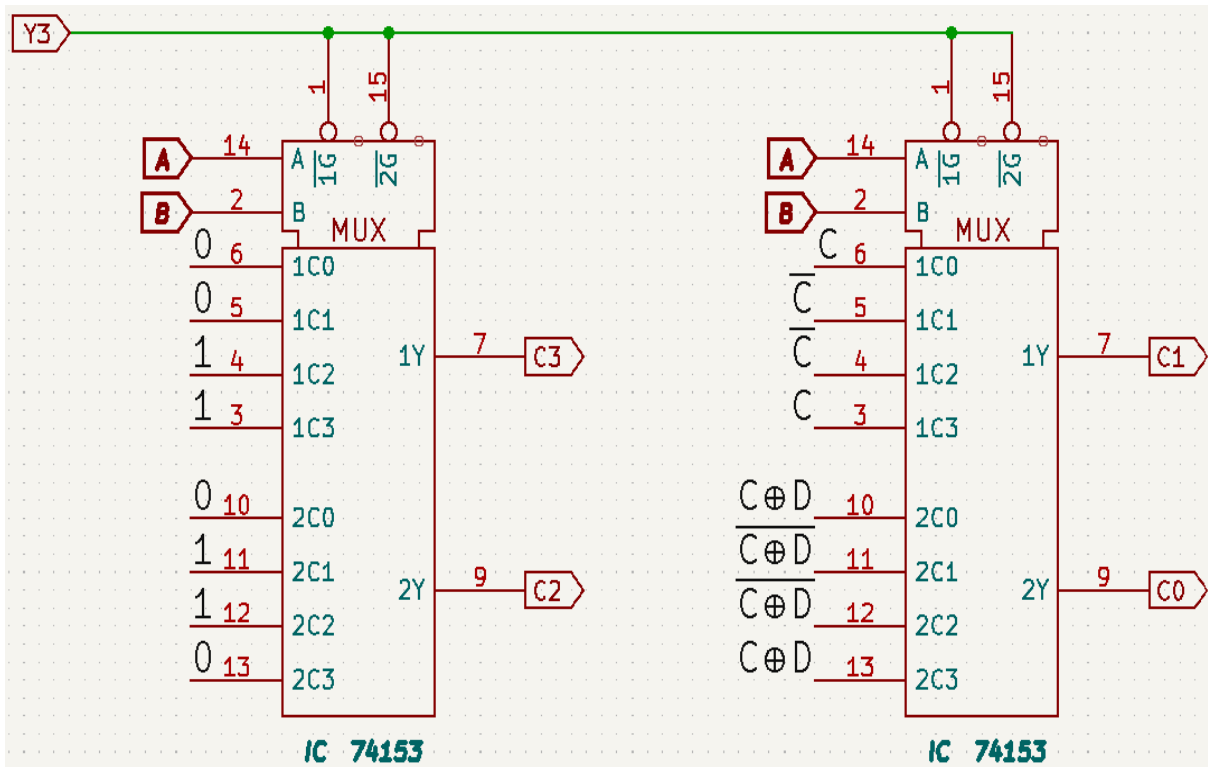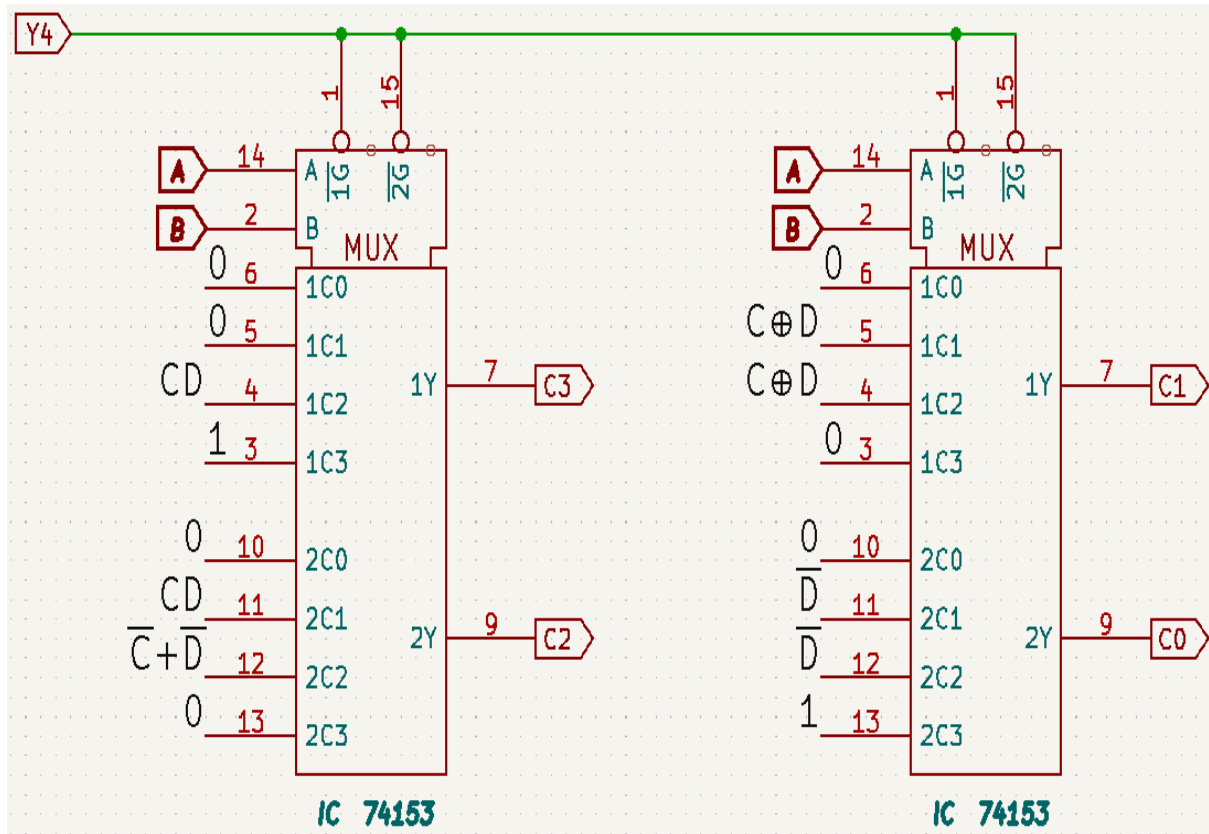**Figure 2.1.5 Gray code to Binary conversion Circuit**

Figure 2.1.6 Excess-3 code to BCD conversion Circuit
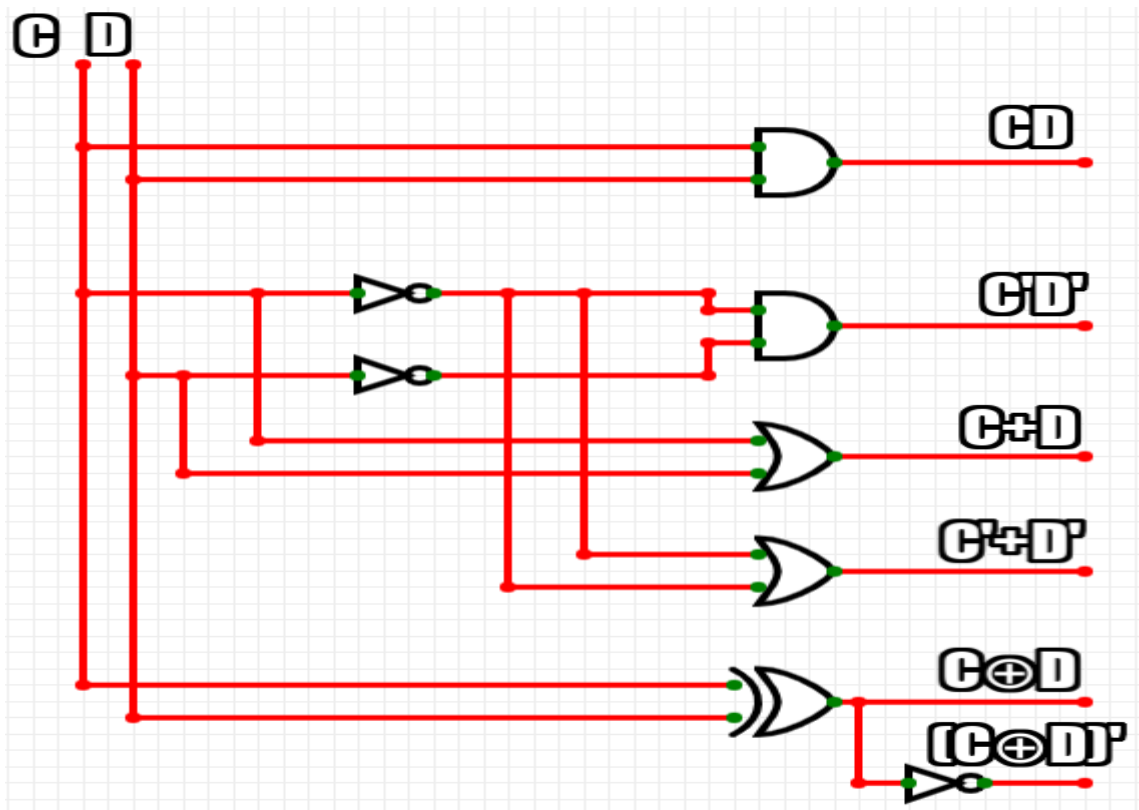
Figure 2.1.7 Logic Diagram using Circuitverse

2.2 COMPONENTS USED

This section shows components used.

2.2.1   SOFTWARE

KiCAD software was used for the design of the circuit.

2.2.2 HARDWARE

	Component	Quantity
1	IC 74153 (Dual 4-input multiplexer)	8
2	IC 74139 (Dual 2-to-4 line Decoder)	1
3	IC 7432 (Quad OR Gate)	1
4	IC 7486 (Quad XOR Gate)	2
5	IC 7408 (Quad 2 input AND gate)	1
6	IC 7404 (Hex Inverter)	2
7	LM7805 IC (5V voltage regulator)	1
8	RED LEDs	4
9	Cathode 7-segment display	4
10	9V battery	1
11	Diodes (1N4007)	16
12	6 Pin Button Switch	6

1) IC 74153 (Dual 4-input multiplexer)

The multiplexer, shortened to "MUX" is a combinational logic circuit designed to switch one of several input lines through to a single common output line by the application of a control signal. IC 74153 is a multiplexer IC (Integrated Circuit) that allows the user to select one of four inputs and send it to the output. It has four data inputs (A0, A1, A2, A3), a selection input (S1, S0) to choose one of the four inputs, and an output (Y).

```
       ___
       1G ☐ 1        16 ☐ VCC
        B ☐ 2        15 ☐ 2G
      1C3 ☐ 3        14 ☐ A
      1C2 ☐ 4   74153 13 ☐ 2C3
      1C1 ☐ 5        12 ☐ 2C2
      1C0 ☐ 6        11 ☐ 2C1
       1Y ☐ 7        10 ☐ 2C0
      GND ☐ 8         9 ☐ 2Y
```
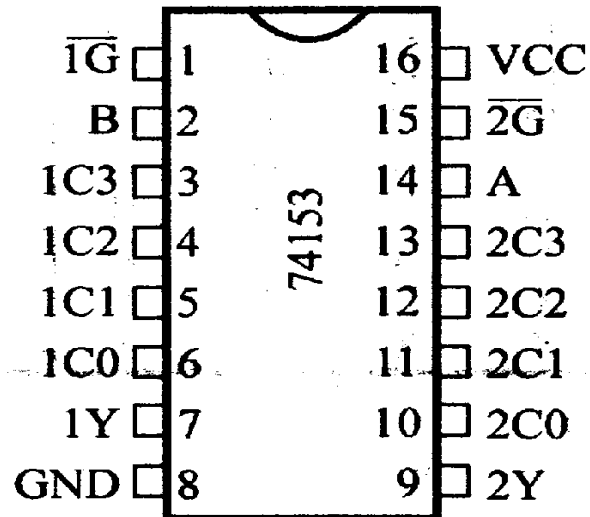
Figure 2.2.2.1 Pin Diagram of IC 74153

2) IC 74139 (Dual 2-to-4 line Decoder)

IC 74139 is a dual 2-to-4 line decoder/demultiplexer integrated circuit. It has two inputs (A, B), two selection inputs (S1, S0), and four outputs (Y0, Y1, Y2, Y3). The device is used to convert two binary inputs into four outputs, where only one output is active at a time based on the selection inputs.

```
       __
       1G ☐ 1        16 ☐ VCC
       1A ☐ 2        15 ☐ 2G
       1B ☐ 3        14 ☐ 2A
      1Y0 ☐ 4        13 ☐ 2B
      1Y1 ☐ 5        12 ☐ 2Y0
      1Y2 ☐ 6        11 ☐ 2Y1
      1Y3 ☐ 7        10 ☐ 2Y2
      GND ☐ 8         9 ☐ 2Y3
```

Figure 2.2.2.2 Pin Diagram of IC 74139

3) IC 7432 (Quad OR Gate)

IC 7432 is a logic gate IC which consist of four OR Gates. The OR gate performs logical OR operation. The OR gates come in form of DIP package ICs. Each gate has three terminal two inputs and one output. The OR gate outputs a high (1) signal if one or both of its inputs are high (1), and outputs a low (0) signal if both inputs are low (0). The inputs of the OR gate are labeled A and B, and the output is labeled Y.
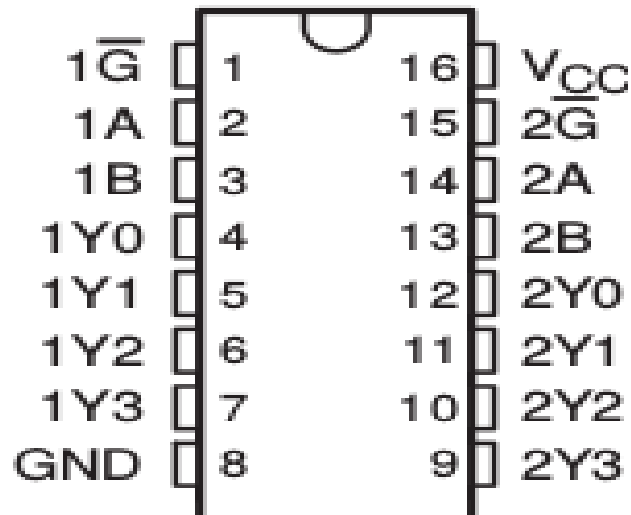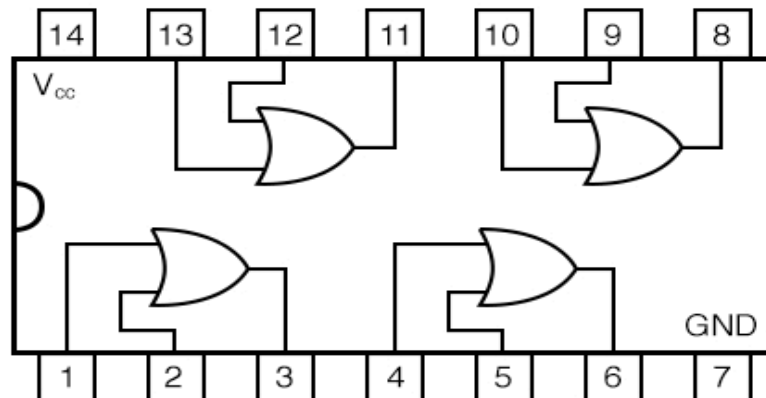

Figure 2.2.2.3 Pin Diagram of IC 7432

4) IC 7486 (Quad XOR Gate)

The IC 7486 is a quad 2-input XOR gate integrated circuit. It consists of four independent gates, each of which performs the logical exclusive OR (XOR) function. The XOR gate outputs a high (1) signal if one, but not both, of its inputs are high (1), and outputs a low (0) signal if both inputs are either high (1) or low (0). The inputs of the XOR gate are labeled A and B, and the output is labeled Y.
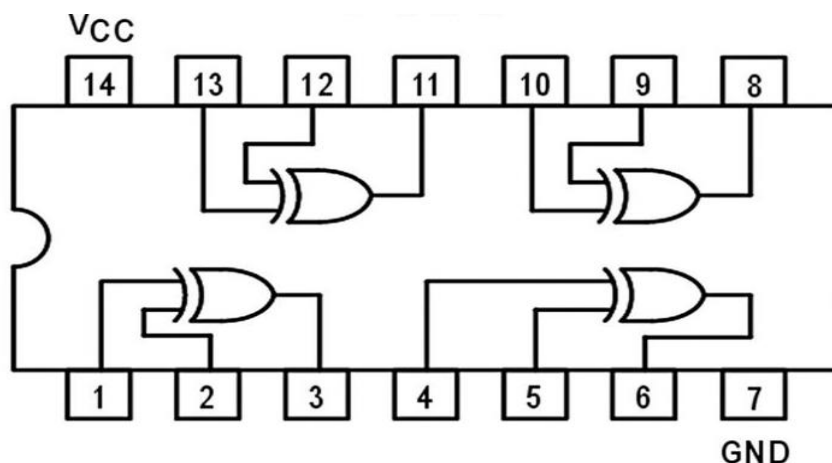
Figure 2.2.2.4 Pin Diagram of IC 7486

5) IC 7408 (Quad 2 input AND gate)

The IC 7408 is a quad 2-input AND gate integrated circuit. It consists of four independent gates, each of which performs the logical AND function. The AND gate outputs a high (1) signal if both of its inputs are high (1), and outputs a low (0) signal if one or both inputs are low (0). The inputs of the AND gate are labeled A and B, and the output is labeled Y.
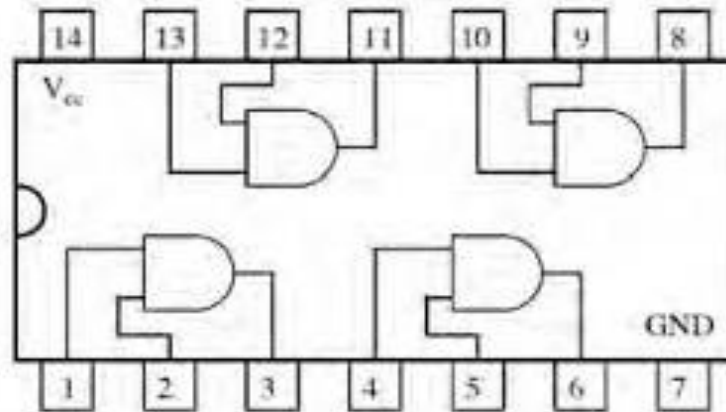
Figure 2.2.2.5 Pin Diagram of IC 7408

6) IC 7404 (Hex Inverter)

The IC 7404 is a hex inverter integrated circuit. It contains six independent inverter gates, each of which performs the logical NOT function. The NOT function, also known as inversion, outputs a low (0) signal if its input is high (1), and outputs a high (1) signal if its input is low (0). The input of the inverter gate is labeled A, and the output is labeled Y.
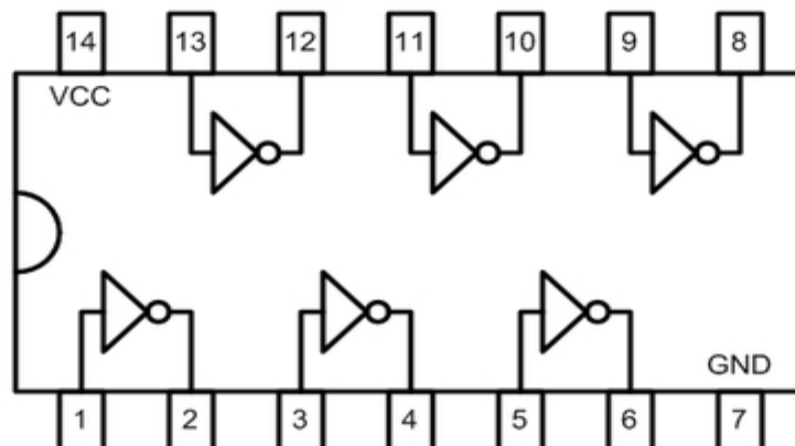
Figure 2.2.2.6 Pin Diagram of IC 7404

2.3 WORKING

The 4-bit binary code converter Circuit using Demultiplexer (DEMUX) and Multiplexer (MUX) works as follows:

- Initially the DEMUX is used to select a Particular Conversion, the output of the DEMUX is applied to the enable of the MUX. The DEMUX is used to select a particular binary conversion out of 4 different conversion. The selection lines of the DEMUX determine the Conversion which has to be performed.

- The inputs A, B, C, D is given once after selecting the conversion which is needed to be performed.

- The logic Gates Like OR, NOT, AND, XOR are Used to Perform Operations on inputs C and D and the outputs of the Logic Gates is then applied to the inputs of the MUX.

- The MUX is used to map the Logic gates input to output and the conversion to gray code or Excess-3 code or binary is performed. The selection lines of the MUX that is A and B determine the mapping of the binary code to the gray code or Excess-3 code.

- The outputs of the MUX represent the converted code in the desired format.

- The Converted output is displayed on the 7 Segment displays along with the LEDs.

Table 1. Truth Table

Table 1.1 Binary to Gray Code

BINARY INPUT				GRAY CODE OUTPUT				REDUCED GRAY CODE OUTPUT			
A	B	C	D	C_3	C_2	C_1	C_0	C_3	C_2	C_1	C_0
0	0	0	0	0	0	0	0	0	0	C	$C \oplus D$
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	$\bar{C}$	$C \oplus D$
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	1	C	$C \oplus D$
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	0	$\bar{C}$	$C \oplus D$
1	1	0	1	1	0	1	1				
1	1	1	0	1	0	0	1				
1	1	1	1	1	0	0	0				

Table 1.2 BCD to Excess-3

BCD INPUT				EXCESS-3 OUTPUT				REDUCED EXCESS-3 OUTPUT			
A	B	C	D	C_3	C_2	C_1	C_0	C_3	C_2	C_1	C_0
0	0	0	0	0	0	1	1	0	$C+D$	$\overline{C \oplus D}$	$\bar{D}$
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	$C+D$	$\bar{C}\,\bar{D}$	$\overline{C \oplus D}$	$\bar{D}$
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	$\bar{C}$	$\bar{C}D$	$\bar{C}\,\bar{D}$	$\bar{C}\,\bar{D}$
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	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				

Table 1.3 Gray Code to Binary

GRAY CODE INPUT				BINARY OUTPUT				REDUCED BINARY OUTPUT			
A	B	C	D	C_3	C_2	C_1	C_0	C_3	C_2	C_1	C_0
0	0	0	0	0	0	0	0	0	0	C	$C \oplus D$
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	1	0	1	$\overline{C}$	$\overline{C \oplus D}$
0	1	0	1	0	1	1	0				
0	1	1	0	0	1	0	0				
0	1	1	1	0	1	0	1				
1	0	0	0	1	1	1	1	1	1	$\overline{C}$	$\overline{C \oplus D}$
1	0	0	1	1	1	1	0				
1	0	1	0	1	1	0	0				
1	0	1	1	1	1	0	1				
1	1	0	0	1	0	0	0	1	0	C	$C \oplus D$
1	1	0	1	1	0	0	1				
1	1	1	0	1	0	1	1				
1	1	1	1	1	0	1	0				

Table 1.4 Excess-3 to BCD

EXCESS-3 INPUT				BCD OUTPUT				REDUCED BCD OUTPUT			
A	B	C	D	C_3	C_2	C_1	C_0	C_3	C_2	C_1	C_0
0	0	0	0	X	X	X	X	0	0	0	0
0	0	0	1	X	X	X	X				
0	0	1	0	X	X	X	X				
0	0	1	1	0	0	0	0				
0	1	0	0	0	0	0	1	0	CD	$C \oplus D$	$\overline{D}$
0	1	0	1	0	0	1	0				
0	1	1	0	0	0	1	1				
0	1	1	1	0	1	0	0				
1	0	0	0	0	1	0	1	CD	$\overline{C}+\overline{D}$	$C \oplus D$	$\overline{D}$
1	0	0	1	0	1	1	0				
1	0	1	0	0	1	1	1				
1	0	1	1	1	0	0	0				
1	1	0	0	1	0	0	1	1	0	0	1
1	1	0	1	X	X	X	X				
1	1	1	0	X	X	X	X				
1	1	1	1	X	X	X	X				

Chapter 3

RESULT AND DISCUSSION

Result:

The 4 Bit Binary Code Converter was successfully implemented using relative ICs on the breadboard. The results showed that the conversion process was fast and efficient with minimal delay. The circuit design was able to accurately convert Binary to Gray code, BCD to Excess-3, Gray code to Binary and Excess-3 to BCD. The results of the 4-bit binary code converter are accurate and consistent as long as the binary numbers are correctly represented.

Discussion:

The 4-bit binary code converter is a useful tool for converting Binary to Gray code, BCD to Excess-3, Gray code to Binary and Excess-3 to BCD.

The implementation of the 4-bit binary code converter can be done using hardware components or software algorithms. Both methods have their advantages and limitations. The hardware implementation provides faster and more efficient conversion but can be expensive and complex to design.

4-bit binary code converter is a digital circuit that can convert a 4-bit binary code into different data encoding formats, such as Gray code, BCD (Binary-coded Decimal), and Excess-3. The conversion is performed using logical operations, such as XOR, AND, OR gates and by using multiplexers (MUX) and Demultiplexers (DEMUX).The 4-bit binary code converter provides versatility in digital systems, enabling efficient and accurate data storage, transmission, and processing. It can be used for binary arithmetic operations, error detection and correction, digital displays, and data encoding. In summary, the 4-bit binary code converter is a fundamental component in digital systems, providing essential data conversion capabilities that support the functioning of more complex digital circuits.

Chapter 4

CONCLUSION

The circuit was implemented through Demultiplexer (DEMUX), Multiplexer (MUX) and Logic gates the inputs were given by 6 Pin Button Switch and the Output bits are connected to LED's and 7 segment displays. In conclusion, the 4-bit binary code converter is a crucial component in many digital systems, and it provides a simple and effective way to convert binary to other forms. The project involves the design and implementation of a circuit that can convert 4-bit binary codes into different data encoding formats, such as Gray code, BCD (Binary-coded Decimal), and Excess-3 The results of the converter can be used in various applications, including digital circuits, computer science, and communication systems, making it an essential tool for modern technology.

Overall, the 4-bit code converter project is a great opportunity to deepen one's understanding of digital systems and gain practical experience in circuit design and digital logic.

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❖ Binary to Excess-3 conversion: https://www.geeksforgeeks.org/code-converters-bcd8421-to-from-excess-3/

❖ LM7805 data sheet : Data sheet acquired from SLVS056J – MAY 1976 – REVISED MAY 2003,Texas Instruments, for μA7800 SERIES POSITIVE-VOLTAGE REGULATORS https://www.sparkfun.com/datasheets/Components/LM7805.pdf

❖ IC 74153 Data Sheet
https://datasheetspdf.com/pdf/248155/NationalSemiconductor/74153/1

❖ IC 74139 Data Sheet https://www.futurlec.com/74LS/74LS139.shtml