Data Communication and Networks

Error Detection and Correction

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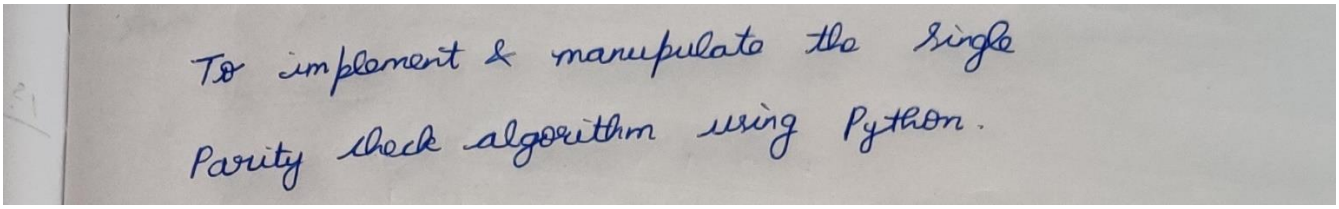
Aim

To implement and manipulate the Error detection and Correction algorithms used in Networking theory using Python

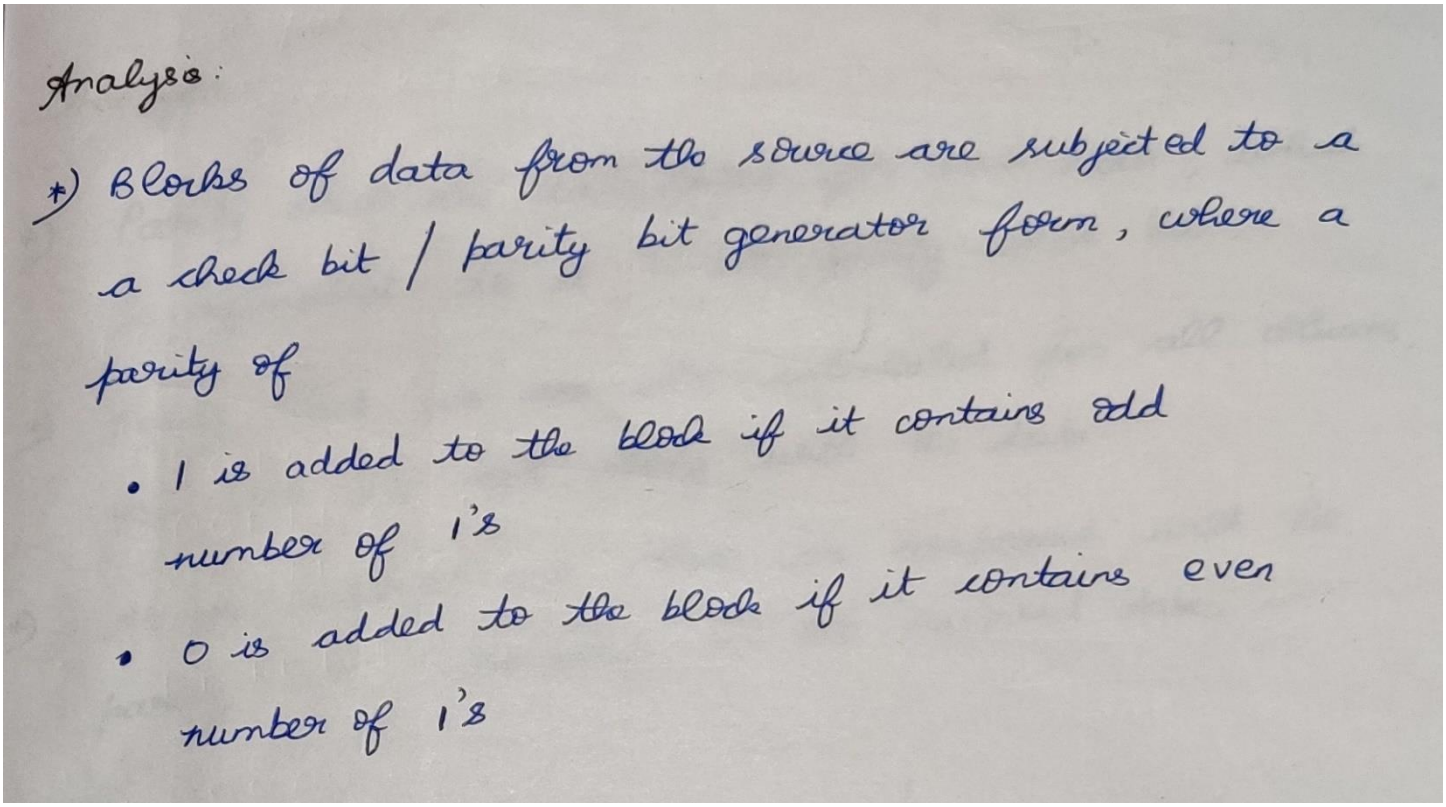
Error Detection Methods

1. Single Parity
2. 2-Dimensional Parity
3. Check-Sum
4. Cyclic Redundancy Check

1)Single Parity


To implement & manipulate the Single Parity check algorithm using Python.

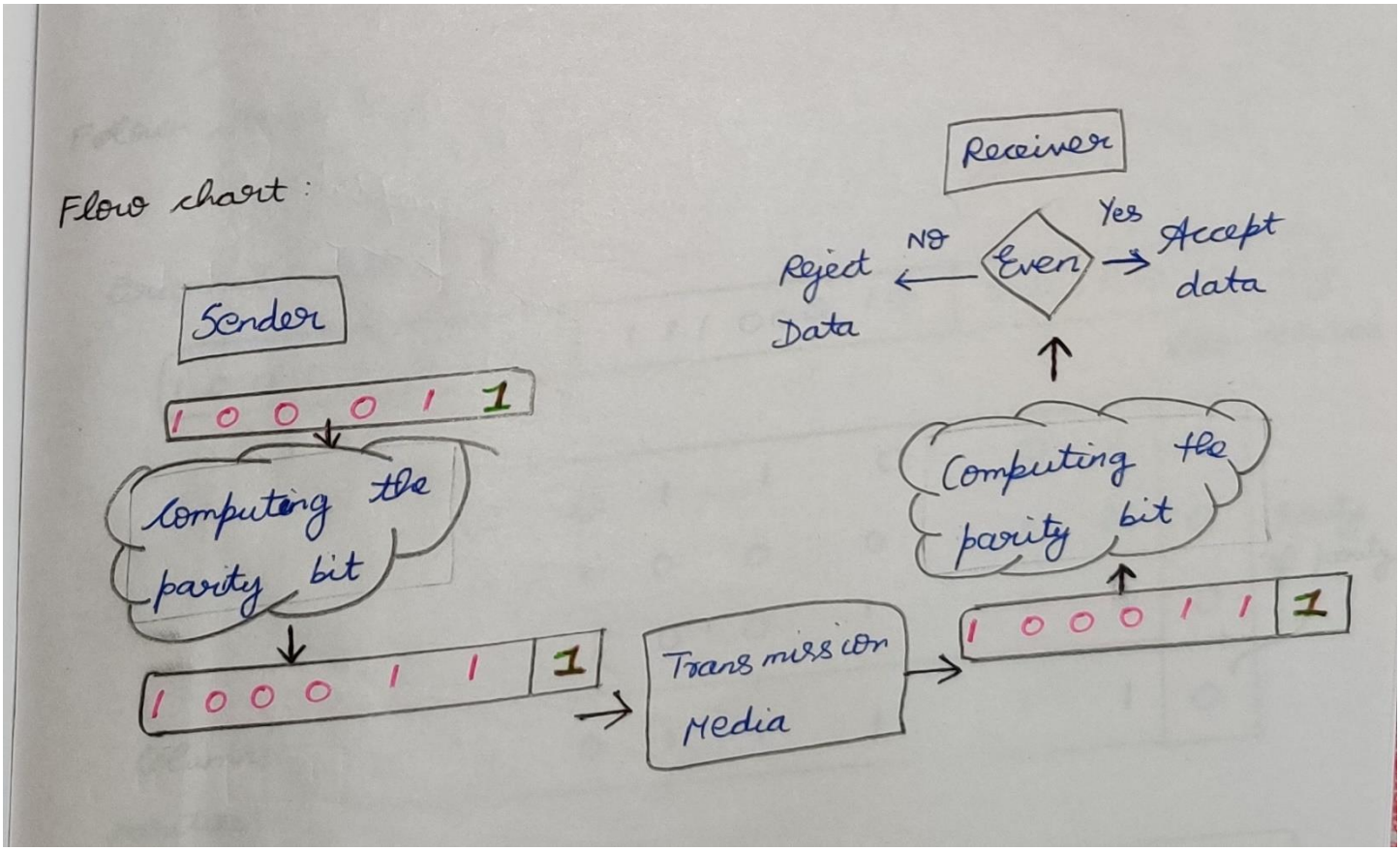
Analysis


Analysis:

*) Blocks of data from the source are subjected to a a check bit / parity bit generator form, where a parity of

- 1 is added to the block if it contains odd number of 1's
- 0 is added to the block if it contains even number of 1's

Flow-chart



Code Structure

```
 1   def Sender(list1,m):...
36
37   def Receiver(ans,str1):...
48
49   if __name__ == '__main__':...)
```

Actual code

```
def Sender(list1,m):
    cnt = 0
    for i in list1:
        if i==1:
            cnt+=1

    if (m=='odd_parity'):
        if (cnt%2!=0):
            print("Input data is odd_parity")

            list1.append(0)
            print("Parity bit 0 is added")
            print("Sender sends the data : ",*list1)
            return list1
        else:
            print("Input data is not in odd parity, so converting")
            list1.append(1)
            print("Parity bit 1 is added")
            print("Sender sends the data : ",*list1)
            return list1

    elif (m=='even_parity'):
        if (cnt%2==0):
            print("Input data is even_parity")

            list1.append(0)
            print("Parity bit 0 is added")
            print("Sender sends the data : ",*list1)
            return list1
        else:
            print("Input data is not in even parity, so converting")
            list1.append(1)
            print("Parity bit 1 is added")
            print("Sender sends the data : ",*list1)
            return list1

```

```
37  def Receiver(ans,str1):
38      cnt = 0
39      for i in ans:
40          if i==1:
41              cnt+=1
42      if (cnt%2==0 and str1=='even_parity'):
43          print("Receiver has received correctly")
44      elif (cnt%2!=0 and str1=='odd_parity'):
45          print("Receiver has received correctly")
46      else :
47          print("Receiver has not received correcly")
48
49  if __name__ == '__main__':
50          list1 = list(map(int,input("Enter the data : ").split()))
51          str1 = input("Enter the mode of parity : ")
52          ans = Sender(list1,str1)
53          print("Receiver receives the data : ",*ans)
54          Receiver(ans,str1)
```

Test-case-1

```
Enter the data : 1 0 0 0 1 1
Enter the mode of parity : odd_parity
Input data is odd_parity
Parity bit 0 is added
Sender sends the data :  1 0 0 0 1 1 0
Receiver receives the data :  1 0 0 0 1 1 0
Receiver has received correctly

***Repl Closed***
```

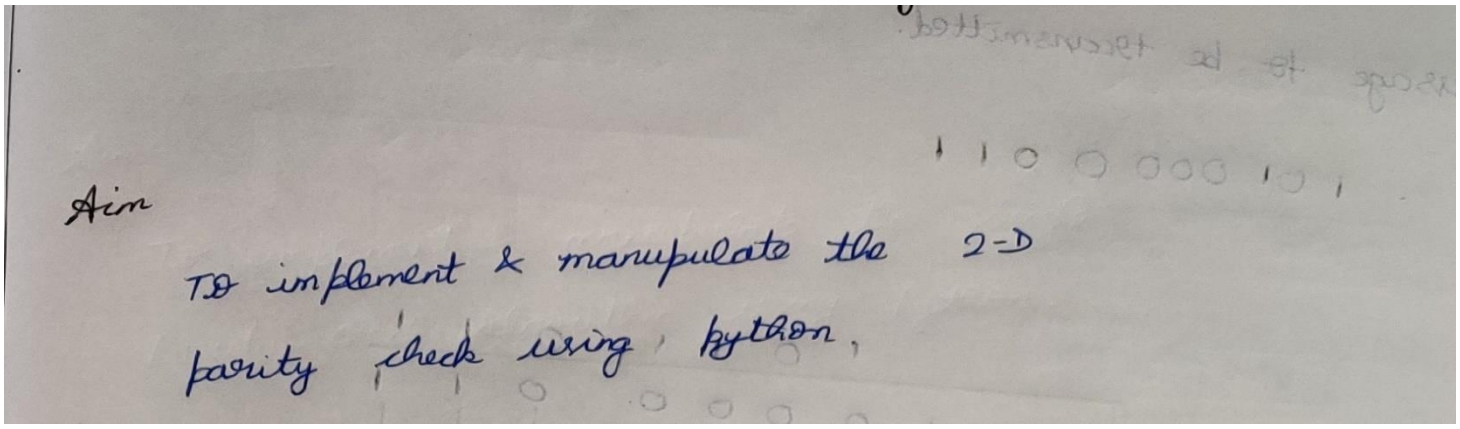
Test-case-2

```
Enter the data : 1 1 0 0 1
Enter the mode of parity : even_parity
Input data is not in even parity, so converting
Parity bit 1 is added
Sender sends the data :  1 1 0 0 1 1
Receiver receives the data :  1 1 0 0 1 1
Receiver has received correctly
```

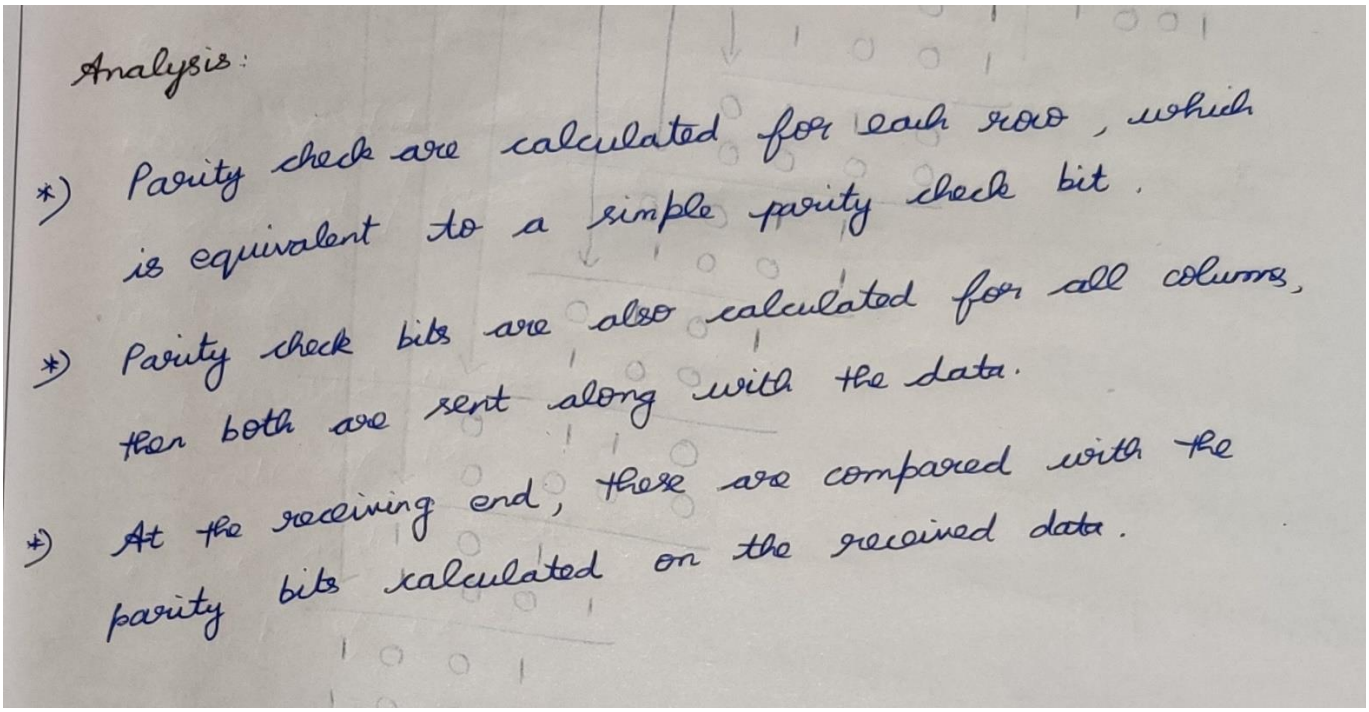
Output

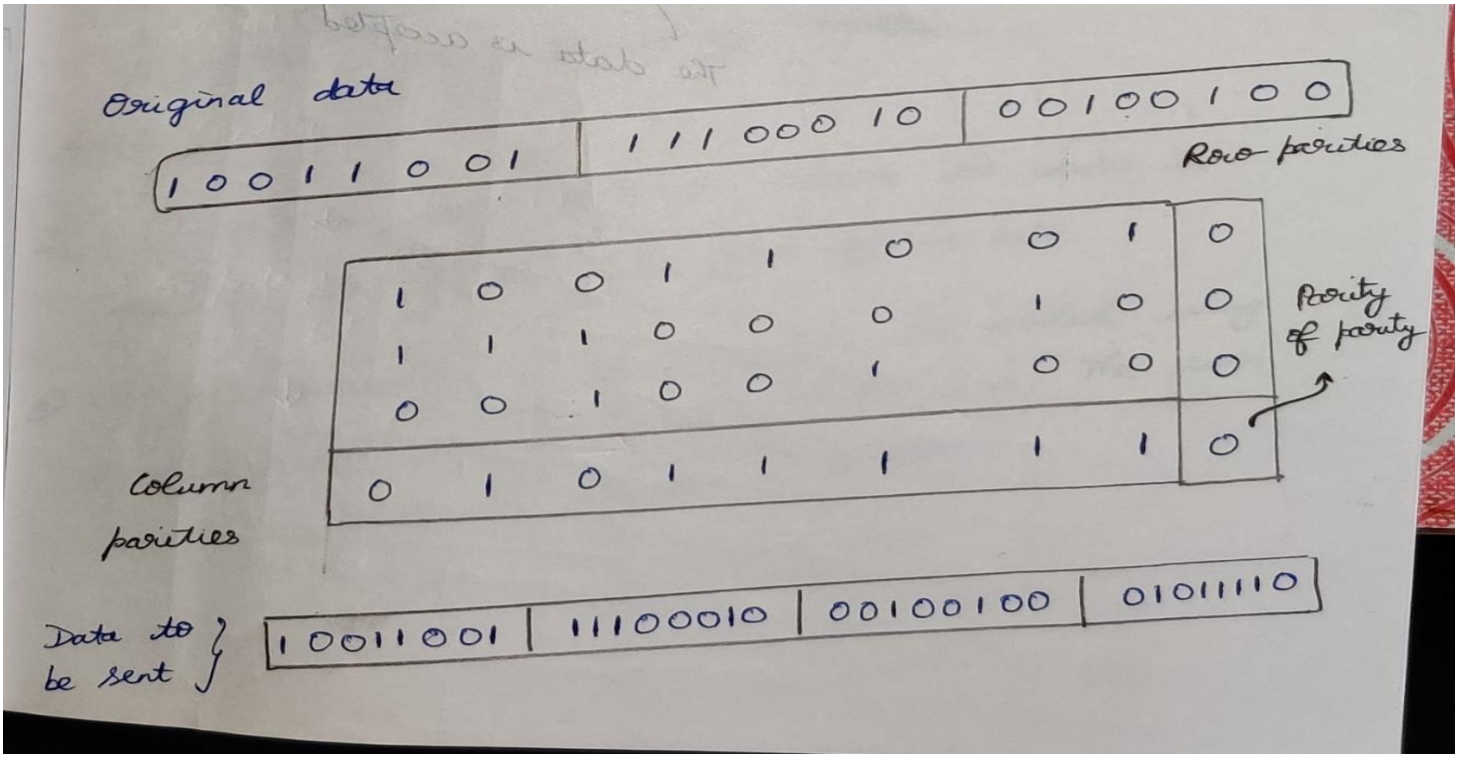
```
Enter the data : 1 0 0 0 1 1
Enter the mode of parity : even_parity
Input data is not in even parity, so converting
Parity bit 1 is added
Sender sends the data :  1 0 0 0 1 1 1
Receiver receives the data :  1 0 0 0 1 1 1
Receiver has received correctly

***Repl Closed***
```

2) Two-Dimensional Parity

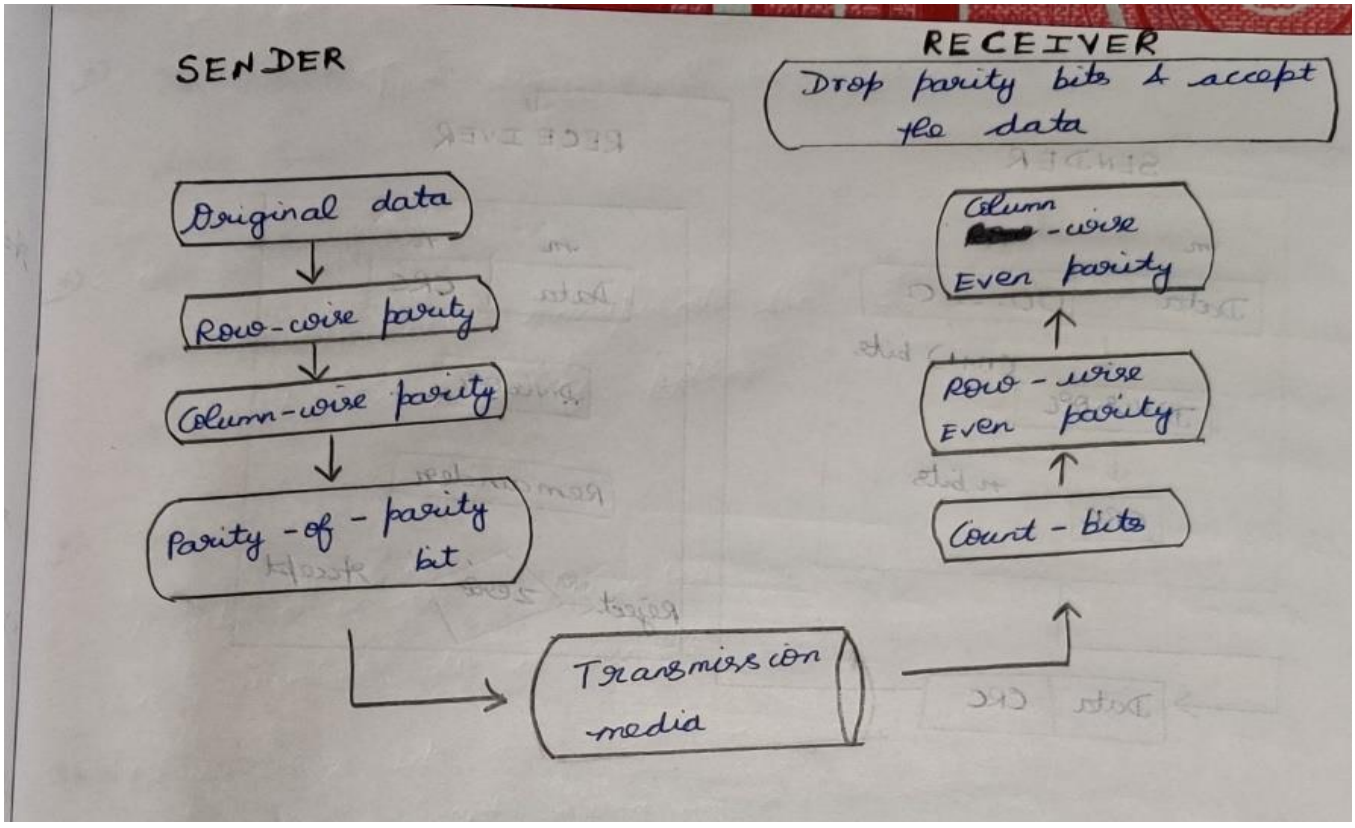


Analysis




Original data
10011001
11100010
00100100
Row parities
Parity of parity
Column parities
Data to be sent
10011001
11100010
00100100
01011110

Flowchart


SENDER
Original data
Row-wise parity
Column-wise parity
Parity-of-parity bit
Transmission media
RECEIVER
Drop parity bits & accept the data
Column -wise Even parity
Row-wise Even parity
Count-bits

Code-structure

```
  1  def get_even(list1):...
  7
  8  def get_odd(list1):...
 15
 16  def check_column(f_list):...
 28
 29  def to_string(listfin, m):...
 32
 33  if __name__ == '__main__':...)
```

Actual-Code

```
 1  def get_even(list1):
 2      if sum(list1) % 2 != 0:
 3          list1.append(1)
 4      else:
 5          list1.append(0)
 6      return list1
 7
 8  def get_odd(list1):
 9      if sum(list1) % 2 == 0:
10          list1.append(1)
11      else:
12          list1.append(0)
13      return list1
14
15  def check_column(f_list):
16      global nop, n
17      list_re = []
18      for i in range(nop + 1):
19          list_re.append(sum([x[i] for x in f_list]))
20      if(n == 2):
```

```
        for i in range(len(list_re)):
            list_re[i] = list_re[i] % 2
    else:
        for i in range(len(list_re)):
            list_re[i] = (list_re[i] + 1) % 2
    return list_re

def to_string(listfin, m):
    string2 = m.join([str(y) for y in listfin])
    return string2

if __name__ == '__main__':
    n = int(input("Enter the standard that sender and receiver are gonna follow :
    print("At the Sender End...")
    data = input("Enter the data to send in binary : ")
    nop = int(
        input("Enter the no of bits per packets for your data have to be encrypted
    extra = (nop - ((len(data)) % nop)) % nop
    extra_bits = str('0' * extra)
    data = extra_bits + data

    list_data = [[int(x) for x in data[i:i + nop]]
                 for i in range(0, len(data), nop)]
    if (n == 2):
        for i in list_data:
            get_even(i)
    else:
        for i in list_data:
            get_odd(i)

    list_data.append(check_column(list_data))
    for l in range(len(list_data)):
        list_data[l] = to_string(list_data[l], '')
    Sender_data = to_string(list_data, ' ')
    print("Code generated by the Sender is : ", Sender_data)
    print("At the receiver End : ")
    n = 0
```

```
    n = int(input("Enter the standard that receiver wants to follow : '1' for 'Odd_
    data = input("Enter the data to send in binary : ")
    nop = int(
        input("Enter the no of bits per packets which sender used to encrypt : "))
    list_data = [[int(x) for x in data[i:i + nop]]
                 for i in range(0, len(data), nop)]
    print("Checking....")
    if n == 1:
        result = [sum(i) % 2 == 1 for i in list_data]
    else:
        result = [sum(i) % 2 == 0 for i in list_data]
    if all(result):
        print("Data received without error ")
    else:
        print("Incorrect Data")
```

Test-case-1

```
Enter the standard that sender and receiver are gonna follow : '1' for '
    Odd_parity'  and '2' for 'Even_parity' : 2
At the Sender End...
Enter the data to send in binary : 10011001111000100010010 0
Enter the no of bits per packets for your data have to be encrypted : 8
Code generated by the Sender is :  100110010 111000100 001001000 010111110
At the receiver End :
Enter the standard that receiver wants to follow : '1' for 'Odd_parity'
    and '2' for 'Even_parity' : 2
Enter the data to send in binary : 10011001111000100010010 0
Enter the no of bits per packets which sender used to encrypt : 8
Checking....
Incorrect Data
```

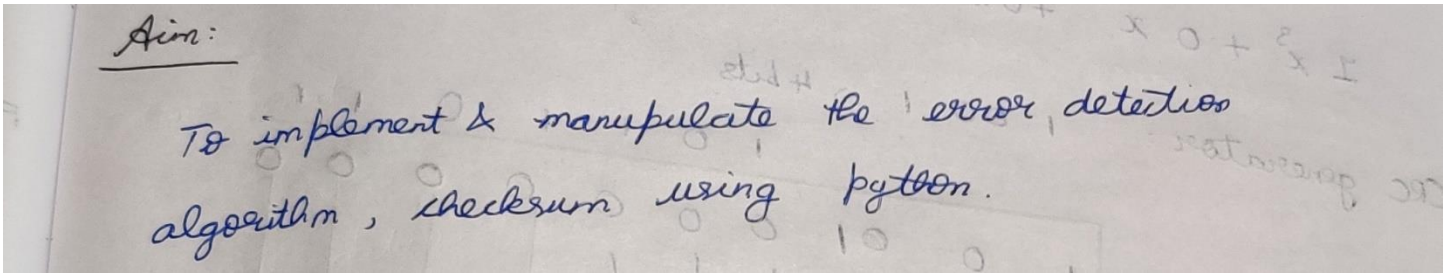
Test-case-2

```
Enter the standard that sender and receiver are gonna follow : '1' for '
    Odd_parity'  and '2' for 'Even_parity' : 1
At the Sender End...
Enter the data to send in binary : 110011001010
Enter the no of bits per packets for your data have to be encrypted : 4
Code generated by the Sender is :  11001 11001 10101 01010
At the receiver End :
Enter the standard that receiver wants to follow : '1' for 'Odd_parity'
    and '2' for 'Even_parity' : 1
Enter the data to send in binary : 11001 11001 10101 01010
Enter the no of bits per packets which sender used to encrypt : 4
```

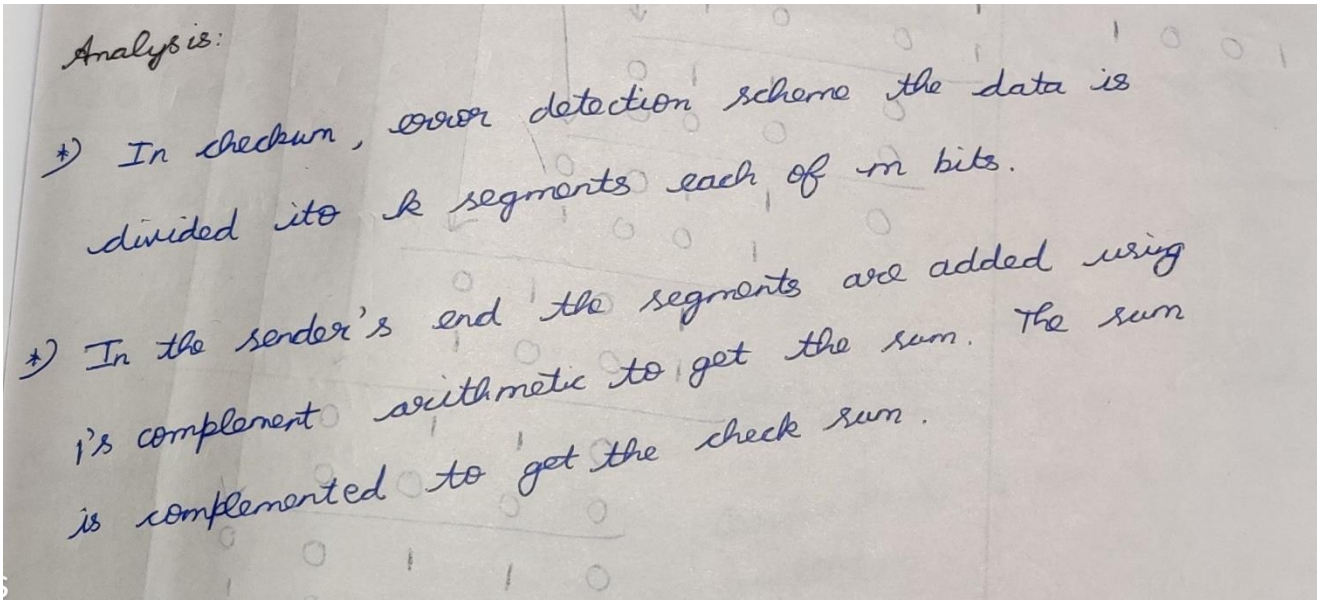
Output

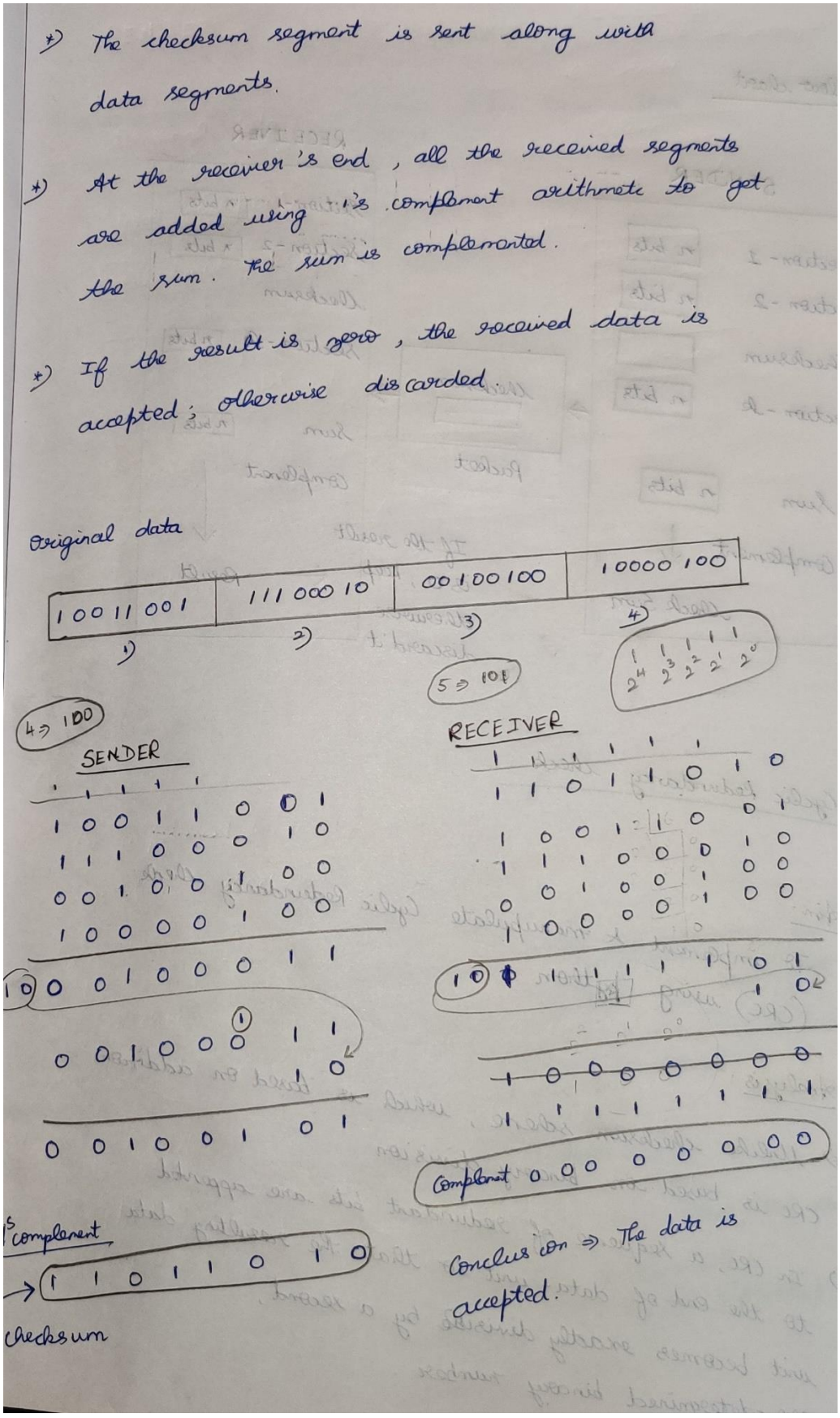
```
Enter the standard that sender and receiver are gonna follow : '1' for '
    Odd_parity'  and '2' for 'Even_parity' : 2
At the Sender End...
Enter the data to send in binary : 100110011110001000100100
Enter the no of bits per packets for your data have to be encrypted : 8
Code generated by the Sender is :  100110010 111000100 001001000 010111110
At the receiver End :
Enter the standard that receiver wants to follow : '1' for 'Odd_parity'
    and '2' for 'Even_parity' : 2
Enter the data to send in binary : 100110010111000100001001000010111110
Enter the no of bits per packets which sender used to encrypt : 8
Checking....
Data received without error
```

3)Checksum

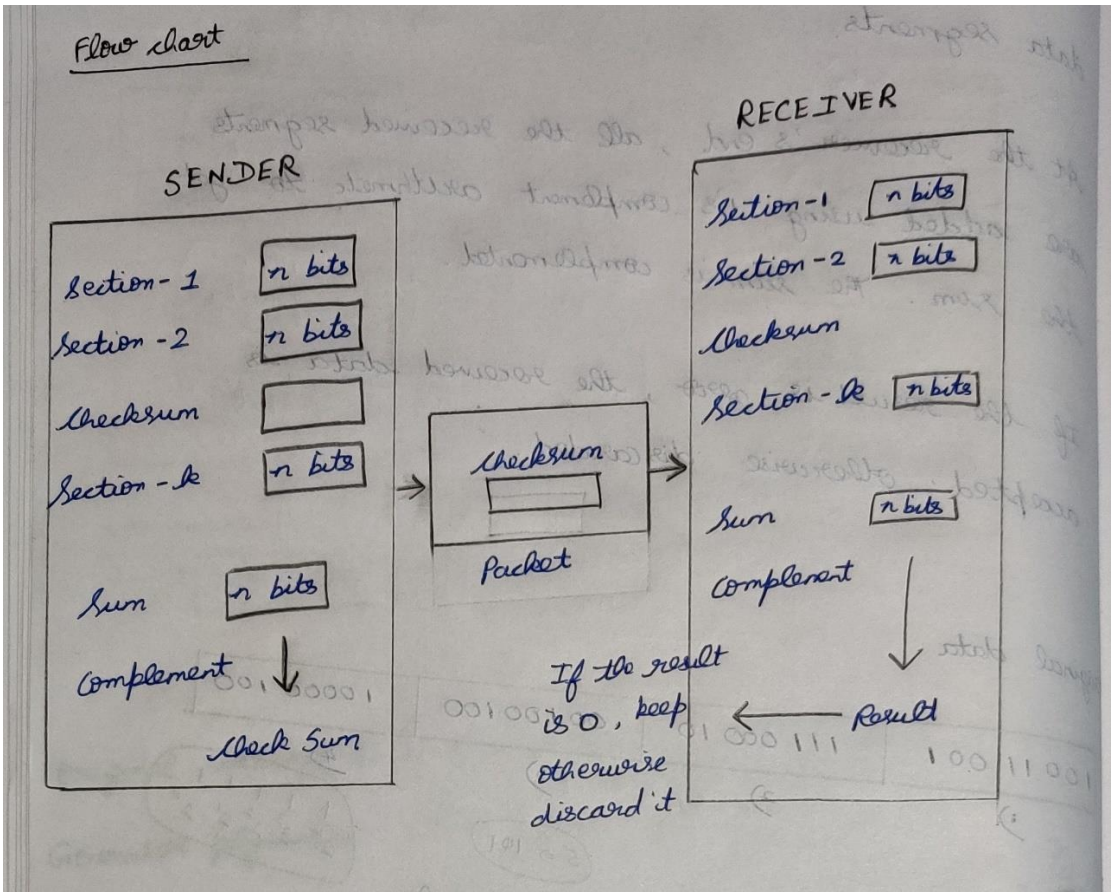


Analysis




*) The checksum segment is sent along with data segments.
*) At the receiver's end, all the received segments are added using 1's complement arithmetic to get the sum. The sum is complemented.
*) If the result is zero, the received data is accepted; otherwise discarded.
Original data
10011001
11100010
00100100
10000100
1)
2)
3)
4)
5 ⇒ 101
4 ⇒ 100
SENDER
RECEIVER
Complement
's complement
Checksum
Conclusion ⇒ The data is accepted.

Flowchart



Code-structure

```
 1  def check(temp):…
10
11  def concatenate_list_data(list):…
16
17  def complement(temp):…
25
26  def Binary_Addition(x, y): …
45
46  def Cyclic_addition(int1,int2):…
57
58  def Access(main_list,n):…
68
69  if __name__ == '__main__':…n
```

Actual-code

```
def check(temp):
    flag = 0
    for i in temp:
        if temp[i]==0:
            flag +=1
    if len(temp)==flag:
        print("Receiver has received the correct data")
    else:
        print("Reciever has not received the correct data")  ## Will check the fina

def concatenate_list_data(list):
    result= ''
    for element in list:
        result += str(element)
    return str(result)  ## Converting the list elements into a single integer

def complement(temp):
    list1 = []
    for i in range(len(temp)):
        if temp[i]==0:
            list1.append(1)
        else:
            list1.append(0)
    return list1  ## Getting the complement of the elements

def Binary_Addition(x, y):
    max_len = max(len(x), len(y))

    x = x.zfill(max_len)
    y = y.zfill(max_len)

    result = ''
    carry = 0

    for i in range(max_len - 1, -1, -1):
        temp = carry
        temp += 1 if x[i] == '1' else 0
        temp += 1 if y[i] == '1' else 0
```

```
        result = ('1' if temp % 2 == 1 else '0') + result
        carry = 0 if temp < 2 else 1     # Compute the carry.

    if carry !=0 : result = '1' + result

    return result.zfill(max_len) ## Doing the binary addition

def Cyclic_addition(int1,int2):
    result = Binary_Addition(int1,int2)
    if len(result)>len(int1):
        while len(result)>len(int1):
            diff     = abs(len(int1)-len(result))
            extra  = result[0:diff]
            result = result[diff:len(result)]
            result = Binary_Addition(result,extra)
        return result
    else:
        return result  ## Taking care of the last carry


def Access(main_list,n):
    main_list_length = int(len(main_list)/n)
    list1 = [main_list[i:i+main_list_length] for i in range(0, len(main_list), main
    int1 = concatenate_list_data(list1[0])   ## 0th index
    int2 = concatenate_list_data(list1[1])  ## 1st index
    temp_ans = Cyclic_addition(int1,int2)
    for i in range(2,len(list1)):
        int1 = concatenate_list_data(list1[i])
        temp_ans = Cyclic_addition(temp_ans,int1)
    return(temp_ans)   ## Accessing the above function

if __name__ == '__main__':
    #main_list = list(map(int,input().split()))
    main_list = [1,0,0,1,1,0,0,1,1,1,1,0,0,0,1,0, 0,0,1,0,0,1,0,0 ,1, 0, 0, 0, 0,1,
    n = 4
    temp = Access(main_list,n)
```

```
74
75      last = []
76      for i in temp:
77          last.append(int(i))
78
79      last = complement(last)
80      print("checksum elements : ",*last)
81      for i in last:
82          main_list.append(i)
83      print("Sender data : ",*main_list)
84      ################################################
85      temp = Access(main_list,n+1)
86      print("At the receiver end : ",*main_list)
87      temp = complement(temp)
88      check(temp)
```

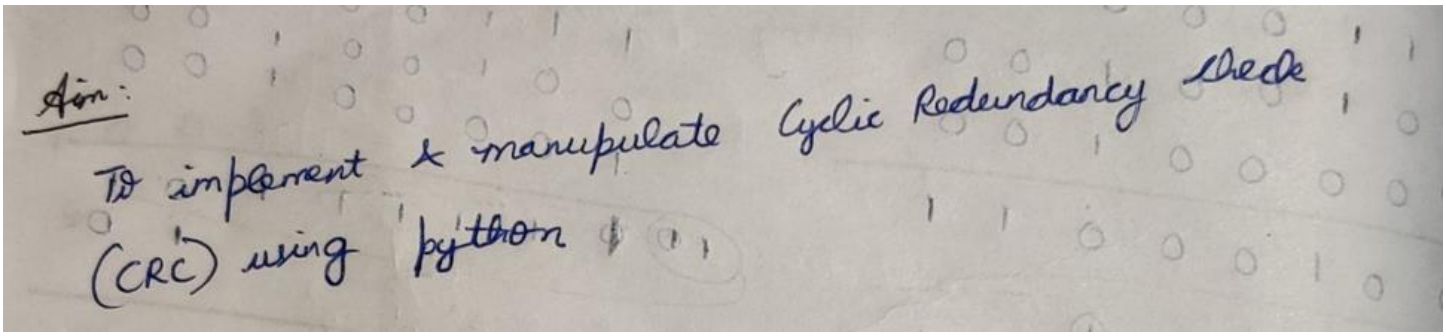
Test-case-1

```
checksum elements :  1 1 0 1 1 0 1 0
Sender data :  1 0 0 1 1 0 0 1 1 1 1 0 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0 1 1 0 1
    1 0 1 0
At the receiver end :  1 0 0 1 1 0 0 1 1 1 1 0 0 0 1 0 0 0 1 0 0 1 0 0 1 0 0 0 0 1 0 0
    1 1 0 1 1 0 1 0
Receiver has received the correct data
```

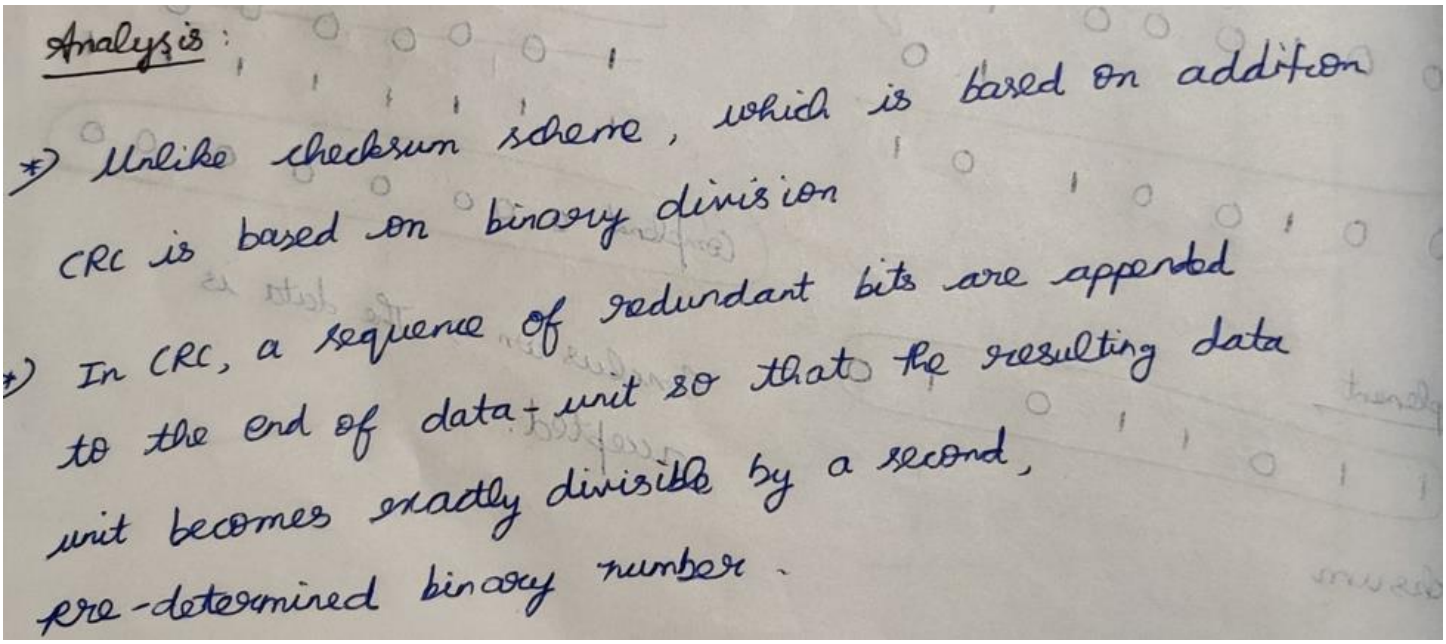
Output

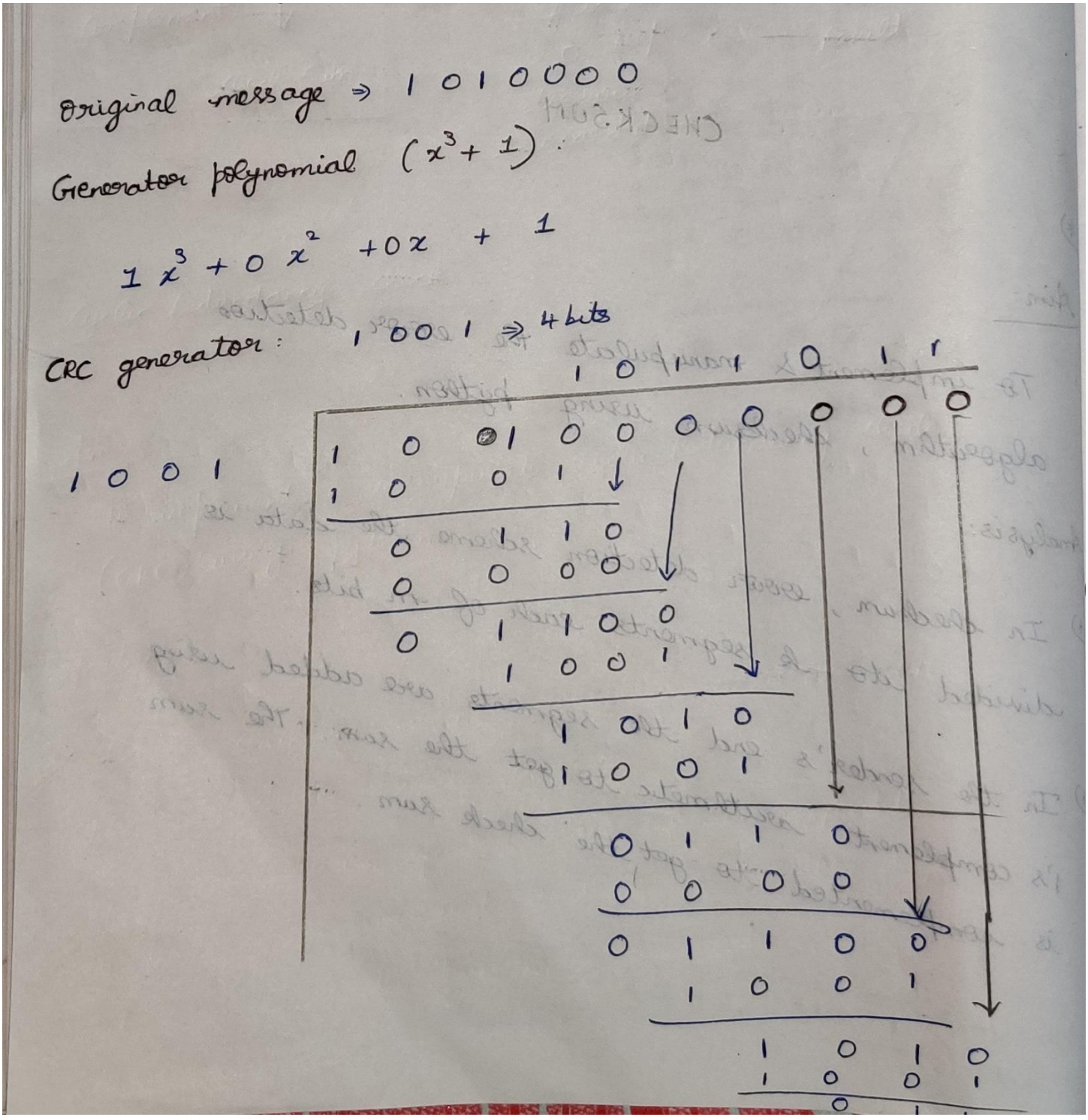
```
checksum elements :  1 1 0 1 1 0 1 0
Sender data :  1 0 0 1 1 0 0 1 1 1 1 0 0 0 1 0 0 0 1 0 0 1 0 0 1 0
     0 0 0 1 0 0 1 1 0 1 1 0 1 0
At the receiver end :  1 0 0 1 1 0 0 1 1 1 1 0 0 0 1 0 0 0 1 0 0 1
     0 0 1 0 0 0 0 1 0 0 1 1 0 1 1 0 1 0
Receiver has received the correct data
```

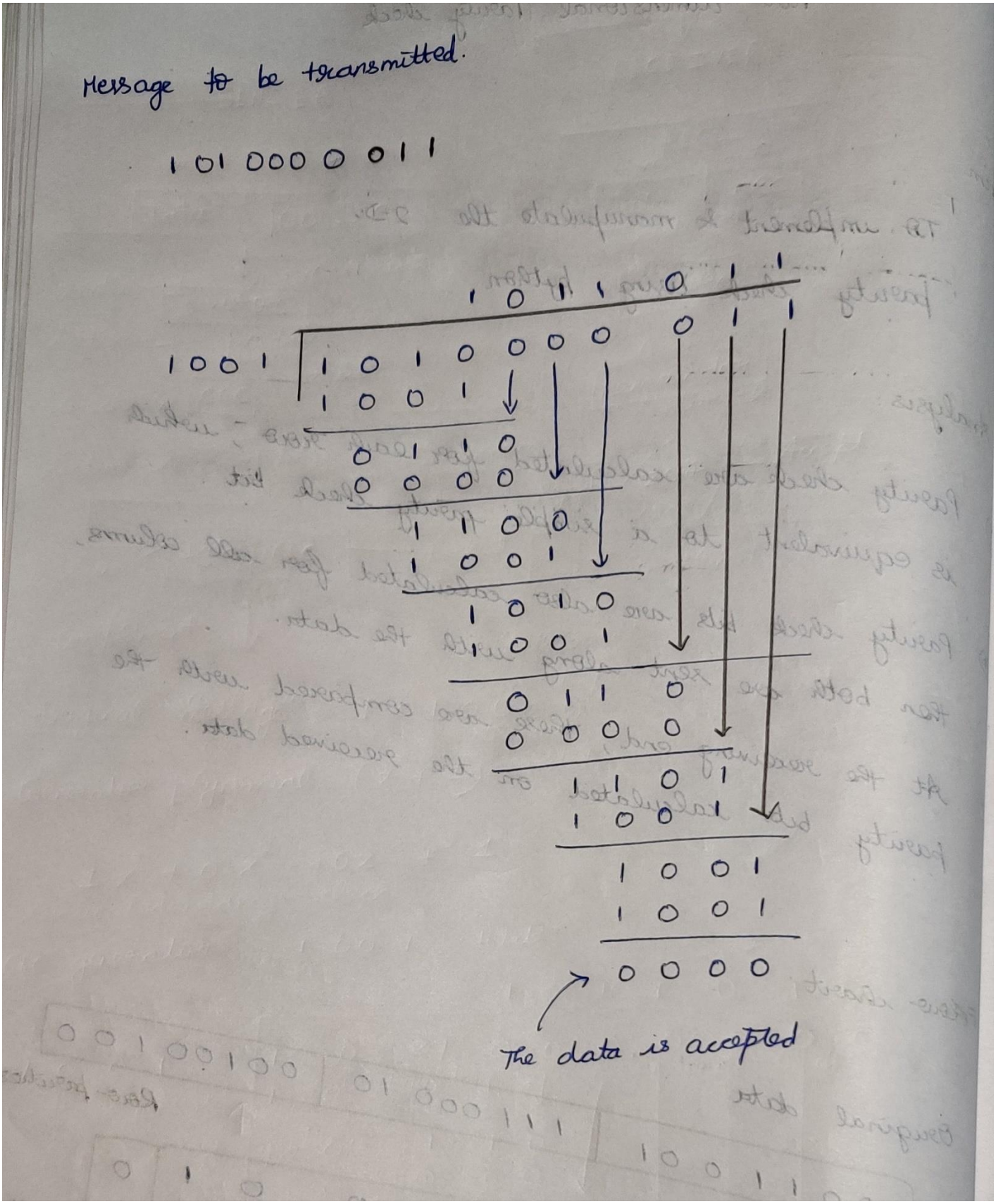
4)Cyclic Redundancy Check


Aim:
To implement & manipulate Cyclic Redundancy check (CRC) using python

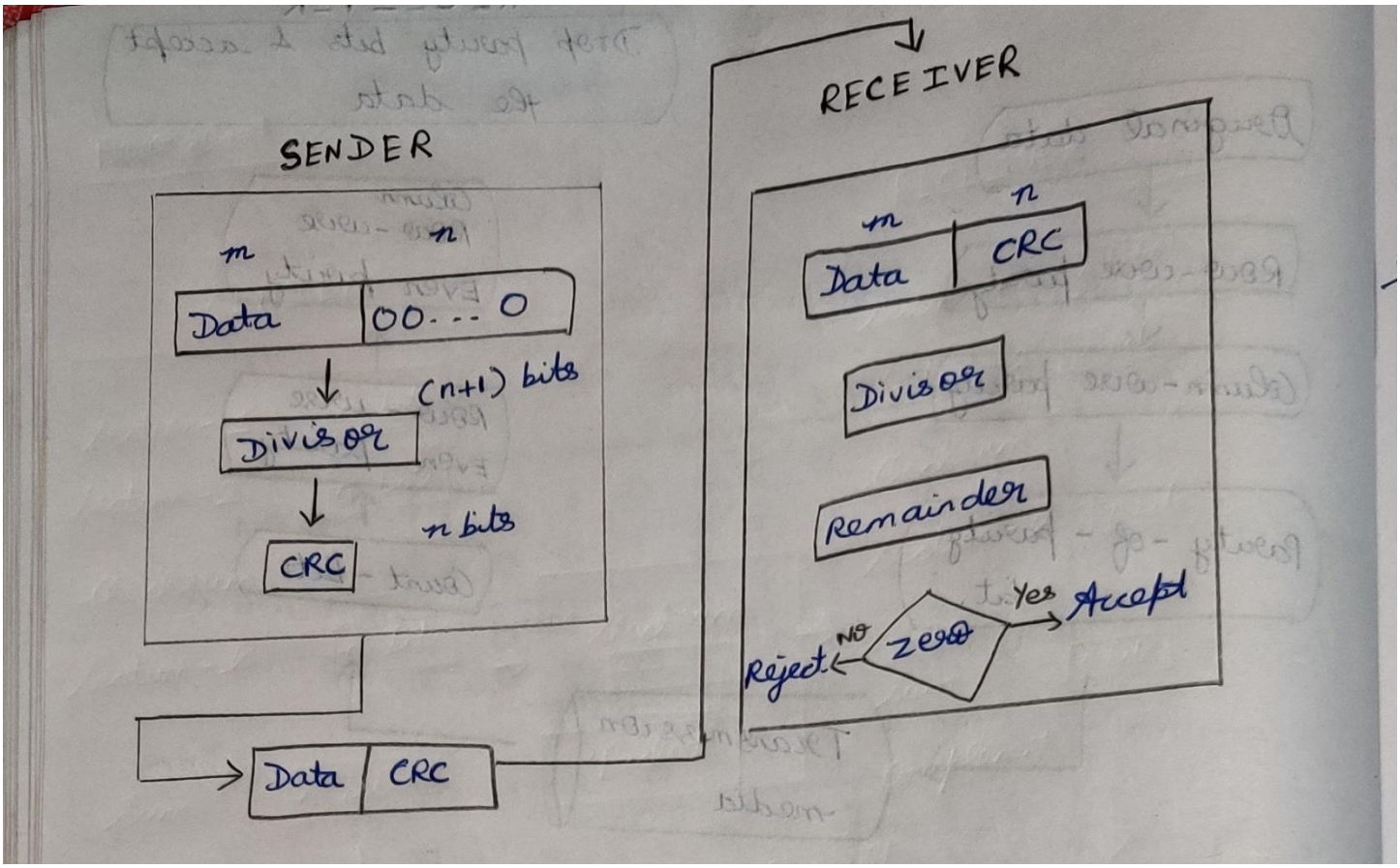
Analysis


Analysis:
* Unlike checksum scheme, which is based on addition CRC is based on binary division
* In CRC, a sequence of redundant bits are appended to the end of data unit so that the resulting data unit becomes exactly divisible by a second, pre-determined binary number.


Original message ⇒ 1 0 1 0 0 0 0
Generator polynomial $(x^3 + 1)$:
$1x^3 + 0x^2 + 0x + 1$
CRC generator: 1 0 0 1 ⇒ 4 bits
1 0 0 1


Message to be transmitted.
1 0 1 0 0 0 0 1 1
1 0 0 1
The data is accepted

Flow-chart



Code-structure

```
 1  def Add_bits(divident,divisor):...
 8
 9  def xor(num1,num2):...
19
20  def Modulo2Division(divident,divisor):...
40
41  def Receiver_check(sender_data,input_divisor):...
50
51  # input
52  # 1) data (divident)
53  # 2) divisor
54  if __name__ == '__main__':...
```

Code

```
def Add_bits(divident,divisor):
    len_divident = len(divident)
    len_divisor   = len(divisor)

    for i in range(len_divisor,(len_divident)+1):
        divident = divident + '0'
    return divident

def xor(num1,num2):
    result = []

    for i in range(1, len(num2)):  ## should go from 1, since
        if num1[i] == num2[i]:
            result.append('0')
        else:
            result.append('1')

    return ''.join(result)

def Modulo2Division(divident,divisor):

    count = len(divisor)
    xor_answer = divident[0:count]  ## Initially slicing out the divident

    while count<len(divident): ## xor division must take place till the en

        if xor_answer[0] == '1':  ## left-most bit is 1
            xor_answer = xor(divisor, xor_answer) + divident[count]  ## st
        elif xor_answer[0]  == '0':  ## Right-most bit is 0
            xor_answer = xor('0'*count, xor_answer) + divident[count]  ##
        count+=1
```

```
        count+=1

    ## Final division
    if xor_answer [0] == '1':
        xor_answer = xor(divisor, xor_answer)
    else:
        xor_answer = xor('0'*count, xor_answer)

    return xor_answer

def Receiver_check(sender_data,input_divisor):
    temp_str = ""
    for i in range(len(input_divisor)-1):
        temp_str = temp_str + '0'
    print("Receiver data : ",sender_data)
    if (Modulo2Division(sender_data,input_divisor)) == (temp_str):
        print("Receiver has received the correct data")
    else:
        print("Receiver has not received the correct data")

# input
# 1) data (divident)
# 2) divisor
if __name__ == '__main__':
    input_divident = input("Enter the data (divident) : ")
    input_divisor  = input("Enter the data (divisor)  : ")
    print("Sender data : ",input_divident)
    extra_bits_divident = Add_bits(input_divident,input_divisor)
    crc = Modulo2Division(extra_bits_divident,input_divisor)

    sender_data = input_divident  + crc

    print("CRC : ",crc)
    print("Sender data along with CRC : ",sender_data)

    Receiver_check(sender_data,input_divisor)
```

Test-case-1

```
Enter the data (divident) : 1010000
Enter the data (divisor)  : 1101
Sender data :  1010000
CRC :  101
Sender data along with CRC :  1010000101
Receiver data :  1010000101
Receiver has not received the correct data
```

Test-case-2

```
Enter the data (divident) : 11000
Enter the data (divisor)  : 1101
Sender data :  11000
CRC :  100
Sender data along with CRC :  11000100
Receiver data :  11000100
Receiver has not received the correct data

***Repl Closed***
```

Result

```
Enter the data (divident) : 100100
Enter the data (divisor)  : 1101
Sender data :  100100
CRC :  001
Sender data along with CRC :  100100001
Receiver data :  100100001
Receiver has received the correct data
```

Sir, the above program code are also available in my github,
https://github.com/PrashanthSingaravelan/WinterSemester-2021/tree/main/CSI2007%20Data%20Communication%20and%20Network/Lab%20Assignment/Assignment-2