Registration Number: 19BCE2119

Name: Gaurav Kumar Singh

Course: Communication and Networks (L15+L16)

Digital Assignment-2 (Error Detection and Correction)

Language Used: Python 3.8.5

Compiler Used: Visual Studio Code

PARITY

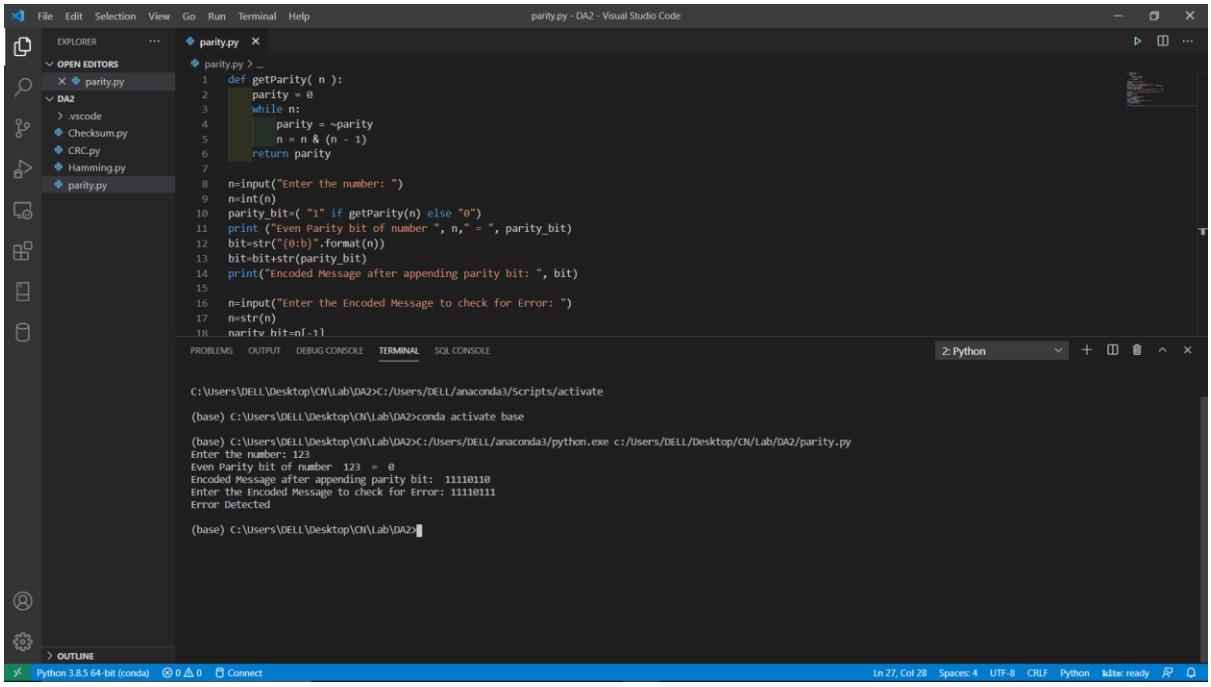
```
def getParity( n ):
    parity = 0
    while n:
        parity = ~parity
        n = n & (n - 1)
    return parity

n=input("Enter the number: ")
n=int(n)
parity_bit=( "1" if getParity(n) else "0")
print ("Even Parity bit of number ", n," = ", parity_bit)
bit=str("{0:b}".format(n))
bit=bit+str(parity_bit)
print("Encoded Message after appending parity bit: ", bit)

n=input("Enter the Encoded Message to check for Error: ")
n=str(n)
parity_bit=n[-1]
orig=""
for i in range(0,len(n)-1):
    orig=orig+n[i]
orig= int(orig,2)
```

```
chk=( "1" if getParity(orig) else "0")
if(chk==parity_bit):
    print("No Error")
else:
    print("Error Detected")
```

OUTPUT



CRC

```
def intToBinary(var):
    return (bin(var).split("0b")[1])


def binToInteger(var):
    return (int(var,2))


def stringToList(s):
    arr=['']*(len(s))
    for i in range(len(s)):
        arr[i]=s[i]
    return arr
```

```
def listToString(arr):
    string = ""
    for element in arr:
        string += element
    return str(string)

def RemainderDecode(divisor,dividend):
    divisor=stringToList(divisor)
    dividend=stringToList(dividend)
    xorterm=''
    counter=0
    divisor=listToString(divisor)
    while (len(str(xorterm))<=len(divisor)):

        if (counter!=len(dividend)):
            xorterm = str(xorterm)+ dividend[counter]
            counter = counter + 1
        if (len(str(xorterm))==len(divisor)):
            xorterm=intToBinary(binToInteger(xorterm)^binToInteger(divisor))
            if (binToInteger(xorterm)==0):
                xorterm=''
        if (counter==len(dividend)):
            if xorterm==divisor:
                xorterm='0'
            return str(xorterm)

def Remainder(divisor, dividend):
    divisor=stringToList(divisor)
    dividend=stringToList(dividend)
    extension=len(divisor) - 1
    for i in range(extension):
```

```
        dividend.append('0')
    xorterm=''
    counter=0
    divisor=listToString(divisor)
    while (len(str(xorterm))<=len(divisor)):

        if (counter!=len(dividend)):
            xorterm = str(xorterm)+ dividend[counter]
            counter = counter + 1
        if (len(str(xorterm))==len(divisor)):
            xorterm=intToBinary(binToInteger(xorterm)^binToInteger(divisor))
            if (binToInteger(xorterm)==0):
                xorterm=''
        if (counter==len(dividend)):
            if xorterm==divisor:
                xorterm='0'
            return str(xorterm)

def CRCEncoder(divisor, dividend, remainder):
    n=len(divisor)-1
    remainder=str(remainder)
    while len(remainder)<n:
        remainder='0'+remainder
    dividend=dividend+remainder
    return dividend

#Encoding
divisor=str(input("Enter Divisor(in Binary Format): "))
dividend=str(input("Enter Dividend(in Binary Format): "))
print("The Remainder(error detection bit) is: ",Remainder(divisor,dividend))
print("The Encoded Message is: ",CRCEncoder(divisor,dividend,Remainder(divisor,dividend)))
```

#Decoding

dividend=str(input("Enter Encoded Message(in Binary Format): "))

divisor=str(input("Enter Divisor(in Binary Format): "))

if(RemainderDecode(divisor,dividend)==''):

    n='0'

else:

    n=RemainderDecode(divisor,dividend)

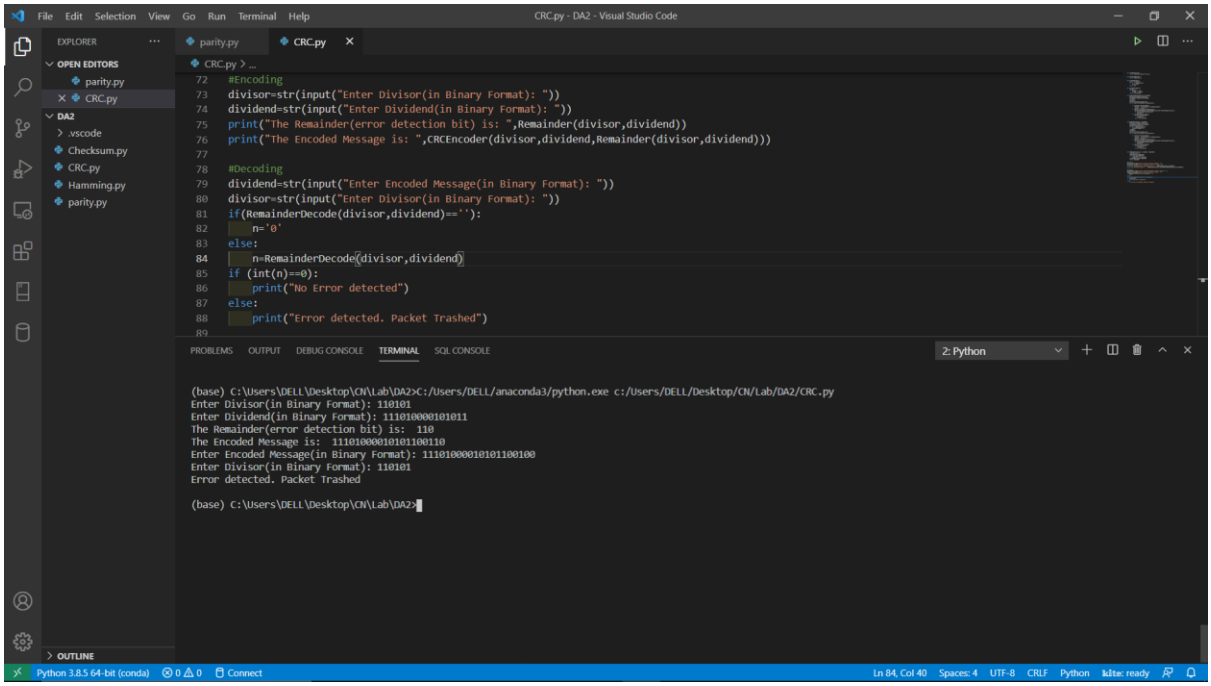
if (int(n)==0):

    print("No Error detected")

else:

    print("Error detected. Packet Trashed")

OUTPUT



CHECKSUM

def flip(c):

    return '1' if (c == '0') else '0'

```
def maximum(a, b):
    if a >= b:
        return a
    else:
        return b

def getOnes(bina):
    ones = ""
    for i in range(len(bina)):
        ones += flip(bina[i])
    return ones

def intToBinary(var):
    return (bin(var).split("0b")[1])

def binToInteger(var):
    return (int(var,2))

def BinaryAddition(binarr):
    sum=0
    for i in range(len(binarr)):
        temp=binToInteger(binarr[i])
        sum=sum+temp
    return(bin(sum).split('0b')[1])

def additionCompression(bina,length):
    arr=['']*2
    counter=0
    while len(bina)>length:
        while (counter < length):
            arr[1]=bina[len(bina)-(counter+1)]+str(arr[1])
```

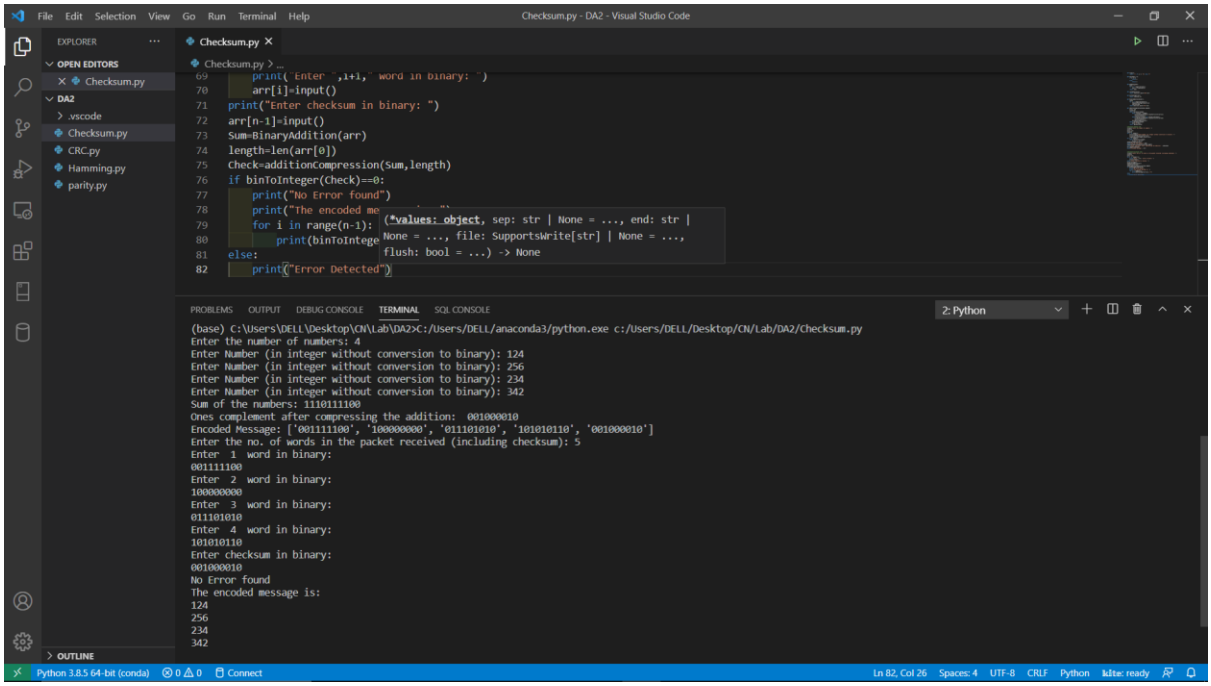
```
            counter=counter+1
        while(counter>=length and counter<len(bina)):
            arr[0]=bina[len(bina)-(counter+1)]+str(arr[0])
            counter=counter+1
        bina=BinaryAddition(arr)
    while len(bina)<length:
        bina='0'+bina
    return getOnes(bina)

#CHECKSUM SENDING SIDE
n=input("Enter the number of numbers: ")
n=int(n)
arr=['']*n
length=0
for i in range(n):
    arr[i]=input("Enter Number (in integer without conversion to binary): ")
    arr[i]=intToBinary(int(arr[i]))
    length=maximum(length,len(arr[i]))
for i in range(n):
    while len(arr[i])<length:
        arr[i]='0'+arr[i]
Sum=BinaryAddition(arr)
print("Sum of the numbers:",Sum)
checksum=additionCompression(Sum,length)
print("Ones complement after compressing the addition: ",checksum)
arr.append(checksum)
print("Encoded Message:", arr)

#CHECKSUM RECIEVING SIDE
n=input("Enter the no. of words in the packet received (including checksum): ")
n=int(n)
```

```
arr=['']*n
for i in range(n-1):
    print("Enter ",i+1," word in binary: ")
    arr[i]=input()
print("Enter checksum in binary: ")
arr[n-1]=input()
Sum=BinaryAddition(arr)
length=len(arr[0])
Check=additionCompression(Sum,length)
if binToInteger(Check)==0:
    print("No Error found")
    print("The encoded message is: ")
    for i in range(n-1):
        print(binToInteger(arr[i]),"\t")
else:
    print("Error Detected")
```

OUTPUT



HAMMING CODE

```
def calcRedundantBits(m):
    for i in range(m):
        if(2**i >= m + i + 1):
            return i
def DecodeProcessing(arr):
    del arr[0]
    temp=(reverseArray(arr))
    return temp
def reverseArray(arr):
    temp=['']*len(arr)
    for i in range(len(arr)):
        temp[i]=arr[-(i+1)]
    return temp
def getParity( n ):
    parity = 0
    while n:
        parity = ~parity
        n = n & (n - 1)
    return parity
def intToBinary(var):
    return (bin(var).split("0b")[1])


def binToInteger(var):
    return (int(var,2))
def listToString(arr):
    string = ""
    for element in arr:
        string += element
    return string
```

```
def arrRedundantPosition(r):
    arrRedundantPos=[]
    for i in range(r):
        arrRedundantPos.append(2**i-1)
    return arrRedundantPos
def getParitybit(arr, r):
    temp=''
    for i in range(len(arr)):
        if (i & r == r) :
            temp += arr[i]
    return "1" if getParity(binToInteger(temp)) else "0"
def Hamming(message):
    print("Original message is: ", message)
    message=intToBinary(message)
    print("Message in binary is: ",message)
    m=len(message)
    r=calcRedundantBits(m)
    print("Number of redundant bits is: ",r)
    n=m+r
    arr=["0"]*n
    arrRedundantPos=arrRedundantPosition(r)
    counter=0
    for i in range(n):
        if i not in arrRedundantPos:
            counter= counter+1
            arr[i]=message[-counter]
    arr.insert(0,'START')
    for i in range(len(arrRedundantPos)):
        arrRedundantPos[i] = arrRedundantPos[i]+1
    for i in arrRedundantPos:
        arr[i]=getParitybit(arr,i)
```

```
    for i in range(len(arr)-1):
        arr[i]=arr[i+1]
    arr.pop(-1)
    HammingArr=reverseArray(arr)
    print("The Hamming Code encoded message is: ",listToString(HammingArr))
def checkArrayRedundantBits(arr):
    n=len(arr)
    arr=[]
    for i in range(n):
        if 2**i < n:
            arr.append(2**i)
    return arr
#Encoding
n=int(input("Enter the number which you want to encode(in Decimals): "))
Hamming(n)
#Decoding
n=input("Enter the Encoded Message: ")
print("The Encoded Message is: ", n)
arr=['']*(len(n))
for i in range(len(n)):
    arr[i]=n[i]
arr=reverseArray(arr)
RedArr=checkArrayRedundantBits(arr)
arr.insert(0,'START')
ErrorPos=[]
for i in RedArr:
    ErrorPos.append(getParitybit(arr, i))
if binToInteger(listToString(reverseArray(ErrorPos)))==0:
    print("No Error Found")
    arr=DecodeProcessing(arr)
else:
```

```
    errordet=binToInteger(listToString(reverseArray(ErrorPos)))
    print("Error Found at ",errordet, " position from the left(Big Endian)")
    arr=DecodeProcessing(arr)
    if (arr[-(errordet)]=='1'):
        arr[-errordet]='0'
    else:
        arr[-errordet]='1'
    print("The Corrected Encoded Message is: ",listToString(arr))
CArrBin=[]
for i in range(len(RedArr)):
    RedArr[i]=-RedArr[i]
for i in range(len(arr)):
    if -(i+1) not in RedArr:
        CArrBin.append(arr[-(i+1)])
CArrBin=reverseArray(CArrBin)
print("The Decoded Message in binary is: ", listToString(CArrBin))
print("The Message Recieved is: ", binToInteger(listToString(CArrBin)))
```

OUTPUT