Q1.

DES ENCRYPTION

PROGRAM CODE:

```
import numpy as np

#Initial permut matrix for the datas
PI = [58, 50, 42, 34, 26, 18, 10, 2,
      60, 52, 44, 36, 28, 20, 12, 4,
      62, 54, 46, 38, 30, 22, 14, 6,
      64, 56, 48, 40, 32, 24, 16, 8,
      57, 49, 41, 33, 25, 17, 9, 1,
      59, 51, 43, 35, 27, 19, 11, 3,
      61, 53, 45, 37, 29, 21, 13, 5,
      63, 55, 47, 39, 31, 23, 15, 7]

#Initial permut made on the key
CP_1 = [57, 49, 41, 33, 25, 17, 9,
        1, 58, 50, 42, 34, 26, 18,
        10, 2, 59, 51, 43, 35, 27,
        19, 11, 3, 60, 52, 44, 36,
        63, 55, 47, 39, 31, 23, 15,
        7, 62, 54, 46, 38, 30, 22,
        14, 6, 61, 53, 45, 37, 29,
        21, 13, 5, 28, 20, 12, 4]

#Permut applied on shifted key to get Ki+1
CP_2 = [14, 17, 11, 24, 1, 5, 3, 28,
        15, 6, 21, 10, 23, 19, 12, 4,
        26, 8, 16, 7, 27, 20, 13, 2,
        41, 52, 31, 37, 47, 55, 30, 40,
        51, 45, 33, 48, 44, 49, 39, 56,
        34, 53, 46, 42, 50, 36, 29, 32]

#Expand matrix to get a 48bits matrix of datas to apply the xor with Ki
E = [32, 1, 2, 3, 4, 5,
     4, 5, 6, 7, 8, 9,
     8, 9, 10, 11, 12, 13,
     12, 13, 14, 15, 16, 17,
     16, 17, 18, 19, 20, 21,
     20, 21, 22, 23, 24, 25,
     24, 25, 26, 27, 28, 29,
     28, 29, 30, 31, 32, 1]

#SBOX
S_BOX = [

[[14, 4, 13, 1, 2, 15, 11, 8, 3, 10, 6, 12, 5, 9, 0, 7],
 [0, 15, 7, 4, 14, 2, 13, 1, 10, 6, 12, 11, 9, 5, 3, 8],
 [4, 1, 14, 8, 13, 6, 2, 11, 15, 12, 9, 7, 3, 10, 5, 0],
```

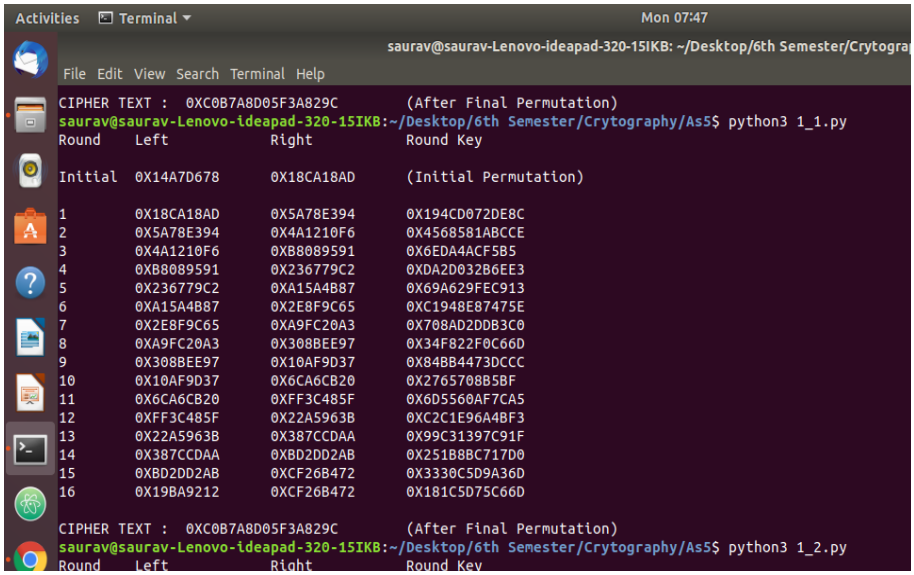
```
 [15, 12, 8, 2, 4, 9, 1, 7, 5, 11, 3, 14, 10, 0, 6, 13],
],

[[15, 1, 8, 14, 6, 11, 3, 4, 9, 7, 2, 13, 12, 0, 5, 10],
 [3, 13, 4, 7, 15, 2, 8, 14, 12, 0, 1, 10, 6, 9, 11, 5],
 [0, 14, 7, 11, 10, 4, 13, 1, 5, 8, 12, 6, 9, 3, 2, 15],
 [13, 8, 10, 1, 3, 15, 4, 2, 11, 6, 7, 12, 0, 5, 14, 9],
],

[[10, 0, 9, 14, 6, 3, 15, 5, 1, 13, 12, 7, 11, 4, 2, 8],
 [13, 7, 0, 9, 3, 4, 6, 10, 2, 8, 5, 14, 12, 11, 15, 1],
 [13, 6, 4, 9, 8, 15, 3, 0, 11, 1, 2, 12, 5, 10, 14, 7],
 [1, 10, 13, 0, 6, 9, 8, 7, 4, 15, 14, 3, 11, 5, 2, 12],
],

[[7, 13, 14, 3, 0, 6, 9, 10, 1, 2, 8, 5, 11, 12, 4, 15],
 [13, 8, 11, 5, 6, 15, 0, 3, 4, 7, 2, 12, 1, 10, 14, 9],
 [10, 6, 9, 0, 12, 11, 7, 13, 15, 1, 3, 14, 5, 2, 8, 4],
 [3, 15, 0, 6, 10, 1, 13, 8, 9, 4, 5, 11, 12, 7, 2, 14],
],

[[2, 12, 4, 1, 7, 10, 11, 6, 8, 5, 3, 15, 13, 0, 14, 9],
 [14, 11, 2, 12, 4, 7, 13, 1, 5, 0, 15, 10, 3, 9, 8, 6],
 [4, 2, 1, 11, 10, 13, 7, 8, 15, 9, 12, 5, 6, 3, 0, 14],
 [11, 8, 12, 7, 1, 14, 2, 13, 6, 15, 0, 9, 10, 4, 5, 3],
],

[[12, 1, 10, 15, 9, 2, 6, 8, 0, 13, 3, 4, 14, 7, 5, 11],
 [10, 15, 4, 2, 7, 12, 9, 5, 6, 1, 13, 14, 0, 11, 3, 8],
 [9, 14, 15, 5, 2, 8, 12, 3, 7, 0, 4, 10, 1, 13, 11, 6],
 [4, 3, 2, 12, 9, 5, 15, 10, 11, 14, 1, 7, 6, 0, 8, 13],
],

[[4, 11, 2, 14, 15, 0, 8, 13, 3, 12, 9, 7, 5, 10, 6, 1],
 [13, 0, 11, 7, 4, 9, 1, 10, 14, 3, 5, 12, 2, 15, 8, 6],
 [1, 4, 11, 13, 12, 3, 7, 14, 10, 15, 6, 8, 0, 5, 9, 2],
 [6, 11, 13, 8, 1, 4, 10, 7, 9, 5, 0, 15, 14, 2, 3, 12],
],

[[13, 2, 8, 4, 6, 15, 11, 1, 10, 9, 3, 14, 5, 0, 12, 7],
 [1, 15, 13, 8, 10, 3, 7, 4, 12, 5, 6, 11, 0, 14, 9, 2],
 [7, 11, 4, 1, 9, 12, 14, 2, 0, 6, 10, 13, 15, 3, 5, 8],
 [2, 1, 14, 7, 4, 10, 8, 13, 15, 12, 9, 0, 3, 5, 6, 11],
]
]

#Permut made after each SBox substitution for each round
P = [16, 7, 20, 21, 29, 12, 28, 17,
     1, 15, 23, 26, 5, 18, 31, 10,
     2, 8, 24, 14, 32, 27, 3, 9,
     19, 13, 30, 6, 22, 11, 4, 25]
```

```
#Final permut for datas after the 16 rounds
FI = [40, 8, 48, 16, 56, 24, 64, 32,
      39, 7, 47, 15, 55, 23, 63, 31,
      38, 6, 46, 14, 54, 22, 62, 30,
      37, 5, 45, 13, 53, 21, 61, 29,
      36, 4, 44, 12, 52, 20, 60, 28,
      35, 3, 43, 11, 51, 19, 59, 27,
      34, 2, 42, 10, 50, 18, 58, 26,
      33, 1, 41, 9, 49, 17, 57, 25]

#Matrix that determine the shift for each round of keys
SHIFT = [1,1,2,2,2,2,2,2,1,2,2,2,2,2,2,1]

def convert(char):
        return "{0:064b}".format(int(char, 16))

def xor(x,y):
        return (int(x,2) ^ int(y,2))

def sbox(text):
        new_text=""
        for i in range(8):
                x=int((text[0]+text[5]),2)
                y=int((text[1:5]),2)
                temp=S_BOX[i][x][y]
                new_text+=('{0:04b}'.format(temp))
                text=text[6:]
        return new_text

def straight(text):
        inp=[0]*32
        x=0
        for i in P:
                inp[x]=text[i-1]
                x=x+1
        inp=".join(inp)
        return inp

def permu(text):
        inp=[0]*64
        x=0
        for i in PI:
                inp[x]=text[i-1]
                x=x+1
        inp=".join(inp)
        return inp

def final(text):
        inp=[0]*64
        x=0
        for i in FI:
                inp[x]=text[i-1]
```

```
                x=x+1
        inp=''.join(inp)
        return inp

def expand(text1):
        text=[0]*48
        x=0
        for i in E:
                text[x]=text1[i-1]
                x=x+1
        text=''.join(text)
        return text

def drop(key):
        l_key=[0]*56
        x=0
        for i in CP_1:
                l_key[x]=key[i-1]
                x=x+1
        return l_key

def compress(key):
        r_key=[0]*48
        x=0
        for i in CP_2:
                r_key[x]=key[i-1]
                x=x+1
        r_key=''.join(r_key)
        return r_key

def shift(key):
        return key[1:]+key[0]

def key_generator(key):
        s_key=convert(key)
        s_key=drop(s_key)
        left=s_key[:len(s_key)//2]
        right=s_key[len(s_key)//2:]
        left=''.join(left)
        right=''.join(right)
        key=[0]*16
        for i in range(16):
                for j in range(SHIFT[i]):
                        left=shift(left)
                        right=shift(right)
                temp=left+right
                key[i]=compress(temp)
                #temp = int(key[i], 2)
                #print(hex(temp).upper())
        return key

def funtion(right,key):
```

```
        text=expand(right)
        text=xor(text,key)
        text=('{0:048b}'.format(text))
        text=sbox(text)
        text=straight(text)
        return text

def swapper(left,right):
        return right,left

def des(inputt,key):
        inputt=convert(inputt)
        text=permu(inputt)
        print("Round\t Left\t\t Right\t\t Round Key\n")
        left=text[:len(text)//2]
        right=text[len(text)//2:]
        left=''.join(left)
        right=''.join(right)
        print("Initial\t",hex(int(left, 2)).upper(),"\t",hex(int(right, 2)).upper(),"\t (Initial
Permutation)\n")
        for i in range(16):
                out=funtion(right,key[i])
                left=xor(left,out)
                left=('{0:032b}'.format(left))
                if(i != 15):
                        left,right=swapper(left,right)
                print(i+1,"\t",hex(int(left, 2)).upper(),"\t",hex(int(right, 2)).upper(),"\
t",hex(int(key[i], 2)).upper())
        text=left+right
        output=final(text)
        print("\nCIPHER TEXT : ",hex(int(output, 2)).upper(),"\t (After Final Permutation)")
        return output

key="AABB09182736CCDD"
key=key_generator(key)

inputt="123456ABCD132536"
ciper=des(inputt,key)
```

OUTPUT:



DES DENCRYPTION

PROGRAM CODE:

```
import numpy as np

#Initial permut matrix for the datas
PI = [58, 50, 42, 34, 26, 18, 10, 2,
      60, 52, 44, 36, 28, 20, 12, 4,
      62, 54, 46, 38, 30, 22, 14, 6,
      64, 56, 48, 40, 32, 24, 16, 8,
      57, 49, 41, 33, 25, 17, 9, 1,
      59, 51, 43, 35, 27, 19, 11, 3,
      61, 53, 45, 37, 29, 21, 13, 5,
      63, 55, 47, 39, 31, 23, 15, 7]

#Initial permut made on the key
CP_1 = [57, 49, 41, 33, 25, 17, 9,
        1, 58, 50, 42, 34, 26, 18,
        10, 2, 59, 51, 43, 35, 27,
        19, 11, 3, 60, 52, 44, 36,
        63, 55, 47, 39, 31, 23, 15,
        7, 62, 54, 46, 38, 30, 22,
        14, 6, 61, 53, 45, 37, 29,
        21, 13, 5, 28, 20, 12, 4]

#Permut applied on shifted key to get Ki+1
CP_2 = [14, 17, 11, 24, 1, 5, 3, 28,
        15, 6, 21, 10, 23, 19, 12, 4,
        26, 8, 16, 7, 27, 20, 13, 2,
        41, 52, 31, 37, 47, 55, 30, 40,
        51, 45, 33, 48, 44, 49, 39, 56,
        34, 53, 46, 42, 50, 36, 29, 32]

#Expand matrix to get a 48bits matrix of datas to apply the xor with Ki
E = [32, 1, 2, 3, 4, 5,
     4, 5, 6, 7, 8, 9,
     8, 9, 10, 11, 12, 13,
     12, 13, 14, 15, 16, 17,
     16, 17, 18, 19, 20, 21,
     20, 21, 22, 23, 24, 25,
     24, 25, 26, 27, 28, 29,
     28, 29, 30, 31, 32, 1]

#SBOX
S_BOX = [

[[14, 4, 13, 1, 2, 15, 11, 8, 3, 10, 6, 12, 5, 9, 0, 7],
 [0, 15, 7, 4, 14, 2, 13, 1, 10, 6, 12, 11, 9, 5, 3, 8],
 [4, 1, 14, 8, 13, 6, 2, 11, 15, 12, 9, 7, 3, 10, 5, 0],
 [15, 12, 8, 2, 4, 9, 1, 7, 5, 11, 3, 14, 10, 0, 6, 13],
```

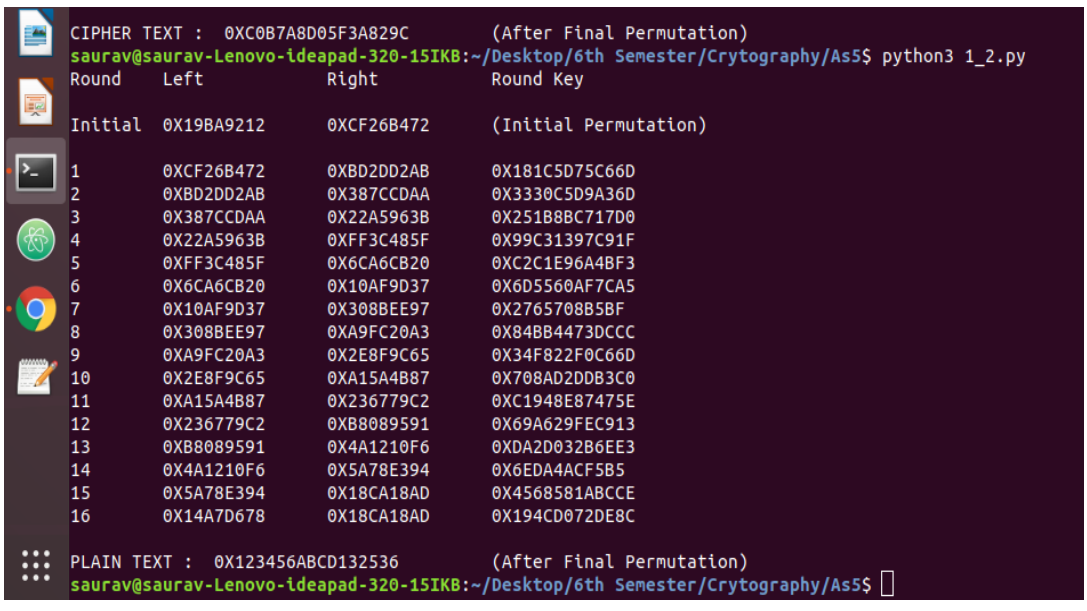
```
],

[[15, 1, 8, 14, 6, 11, 3, 4, 9, 7, 2, 13, 12, 0, 5, 10],
 [3, 13, 4, 7, 15, 2, 8, 14, 12, 0, 1, 10, 6, 9, 11, 5],
 [0, 14, 7, 11, 10, 4, 13, 1, 5, 8, 12, 6, 9, 3, 2, 15],
 [13, 8, 10, 1, 3, 15, 4, 2, 11, 6, 7, 12, 0, 5, 14, 9],
],

[[10, 0, 9, 14, 6, 3, 15, 5, 1, 13, 12, 7, 11, 4, 2, 8],
 [13, 7, 0, 9, 3, 4, 6, 10, 2, 8, 5, 14, 12, 11, 15, 1],
 [13, 6, 4, 9, 8, 15, 3, 0, 11, 1, 2, 12, 5, 10, 14, 7],
 [1, 10, 13, 0, 6, 9, 8, 7, 4, 15, 14, 3, 11, 5, 2, 12],
],

[[7, 13, 14, 3, 0, 6, 9, 10, 1, 2, 8, 5, 11, 12, 4, 15],
 [13, 8, 11, 5, 6, 15, 0, 3, 4, 7, 2, 12, 1, 10, 14, 9],
 [10, 6, 9, 0, 12, 11, 7, 13, 15, 1, 3, 14, 5, 2, 8, 4],
 [3, 15, 0, 6, 10, 1, 13, 8, 9, 4, 5, 11, 12, 7, 2, 14],
],

[[2, 12, 4, 1, 7, 10, 11, 6, 8, 5, 3, 15, 13, 0, 14, 9],
 [14, 11, 2, 12, 4, 7, 13, 1, 5, 0, 15, 10, 3, 9, 8, 6],
 [4, 2, 1, 11, 10, 13, 7, 8, 15, 9, 12, 5, 6, 3, 0, 14],
 [11, 8, 12, 7, 1, 14, 2, 13, 6, 15, 0, 9, 10, 4, 5, 3],
],

[[12, 1, 10, 15, 9, 2, 6, 8, 0, 13, 3, 4, 14, 7, 5, 11],
 [10, 15, 4, 2, 7, 12, 9, 5, 6, 1, 13, 14, 0, 11, 3, 8],
 [9, 14, 15, 5, 2, 8, 12, 3, 7, 0, 4, 10, 1, 13, 11, 6],
 [4, 3, 2, 12, 9, 5, 15, 10, 11, 14, 1, 7, 6, 0, 8, 13],
],

[[4, 11, 2, 14, 15, 0, 8, 13, 3, 12, 9, 7, 5, 10, 6, 1],
 [13, 0, 11, 7, 4, 9, 1, 10, 14, 3, 5, 12, 2, 15, 8, 6],
 [1, 4, 11, 13, 12, 3, 7, 14, 10, 15, 6, 8, 0, 5, 9, 2],
 [6, 11, 13, 8, 1, 4, 10, 7, 9, 5, 0, 15, 14, 2, 3, 12],
],

[[13, 2, 8, 4, 6, 15, 11, 1, 10, 9, 3, 14, 5, 0, 12, 7],
 [1, 15, 13, 8, 10, 3, 7, 4, 12, 5, 6, 11, 0, 14, 9, 2],
 [7, 11, 4, 1, 9, 12, 14, 2, 0, 6, 10, 13, 15, 3, 5, 8],
 [2, 1, 14, 7, 4, 10, 8, 13, 15, 12, 9, 0, 3, 5, 6, 11],
]
]

#Permut made after each SBox substitution for each round
P = [16, 7, 20, 21, 29, 12, 28, 17,
     1, 15, 23, 26, 5, 18, 31, 10,
     2, 8, 24, 14, 32, 27, 3, 9,
     19, 13, 30, 6, 22, 11, 4, 25]

#Final permut for datas after the 16 rounds
```

```
FI = [40, 8, 48, 16, 56, 24, 64, 32,
      39, 7, 47, 15, 55, 23, 63, 31,
      38, 6, 46, 14, 54, 22, 62, 30,
      37, 5, 45, 13, 53, 21, 61, 29,
      36, 4, 44, 12, 52, 20, 60, 28,
      35, 3, 43, 11, 51, 19, 59, 27,
      34, 2, 42, 10, 50, 18, 58, 26,
      33, 1, 41, 9, 49, 17, 57, 25]

#Matrix that determine the shift for each round of keys
SHIFT = [1,1,2,2,2,2,2,2,1,2,2,2,2,2,2,1]

def convert(char):
        return "{0:064b}".format(int(char, 16))

def xor(x,y):
        return (int(x,2) ^ int(y,2))

def sbox(text):
        new_text=""
        for i in range(8):
                x=int((text[0]+text[5]),2)
                y=int((text[1:5]),2)
                temp=S_BOX[i][x][y]
                new_text+=('{0:04b}'.format(temp))
                text=text[6:]
        return new_text

def straight(text):
        inp=[0]*32
        x=0
        for i in P:
                inp[x]=text[i-1]
                x=x+1
        inp=''.join(inp)
        return inp

def permu(text):
        inp=[0]*64
        x=0
        for i in PI:
                inp[x]=text[i-1]
                x=x+1
        inp=''.join(inp)
        return inp

def final(text):
        inp=[0]*64
        x=0
        for i in FI:
                inp[x]=text[i-1]
                x=x+1
```

```
        inp=''.join(inp)
        return inp

def expand(text1):
        text=[0]*48
        x=0
        for i in E:
                text[x]=text1[i-1]
                x=x+1
        text=''.join(text)
        return text

def drop(key):
        l_key=[0]*56
        x=0
        for i in CP_1:
                l_key[x]=key[i-1]
                x=x+1
        return l_key

def compress(key):
        r_key=[0]*48
        x=0
        for i in CP_2:
                r_key[x]=key[i-1]
                x=x+1
        r_key=''.join(r_key)
        return r_key

def shift(key):
        return key[1:]+key[0]

def key_generator(key):
        s_key=convert(key)
        s_key=drop(s_key)
        left=s_key[:len(s_key)//2]
        right=s_key[len(s_key)//2:]
        left=''.join(left)
        right=''.join(right)
        key=[0]*16
        for i in range(16):
                for j in range(SHIFT[i]):
                        left=shift(left)
                        right=shift(right)
                temp=left+right
                key[i]=compress(temp)
                #temp = int(key[i], 2)
                #print(hex(temp).upper())
        return key

def funtion(right,key):
        text=expand(right)
```

```
        text=xor(text,key)
        text=('{0:048b}'.format(text))
        text=sbox(text)
        text=straight(text)
        return text

def swapper(left,right):
        return right,left

def des(inputt,key):
        inputt=convert(inputt)
        text=permu(inputt)
        print("Round\t Left\t\t Right\t\t Round Key\n")
        left=text[:len(text)//2]
        right=text[len(text)//2:]
        left=''.join(left)
        right=''.join(right)
        print("Initial\t",hex(int(left, 2)).upper(),"\t",hex(int(right, 2)).upper(),"\t (Initial
Permutation)\n")
        for i in range(16):
                out=funtion(right,key[15-i])
                left=xor(left,out)
                left=('{0:032b}'.format(left))
                if(i != 15):
                        left,right=swapper(left,right)
                print(i+1,"\t",hex(int(left, 2)).upper(),"\t",hex(int(right, 2)).upper(),"\
t",hex(int(key[15-i], 2)).upper())
        text=left+right
        output=final(text)
        print("\nPLAIN TEXT : ",hex(int(output, 2)).upper(),"\t (After Final Permutation)")
        return output

key="AABB09182736CCDD"
key=key_generator(key)

inputt="C0B7A8D05F3A829C"
ciper=des(inputt,key)
```

OUTPUT:



Q2.

AES
(128 bit key and message)

PROGRAM CODE:

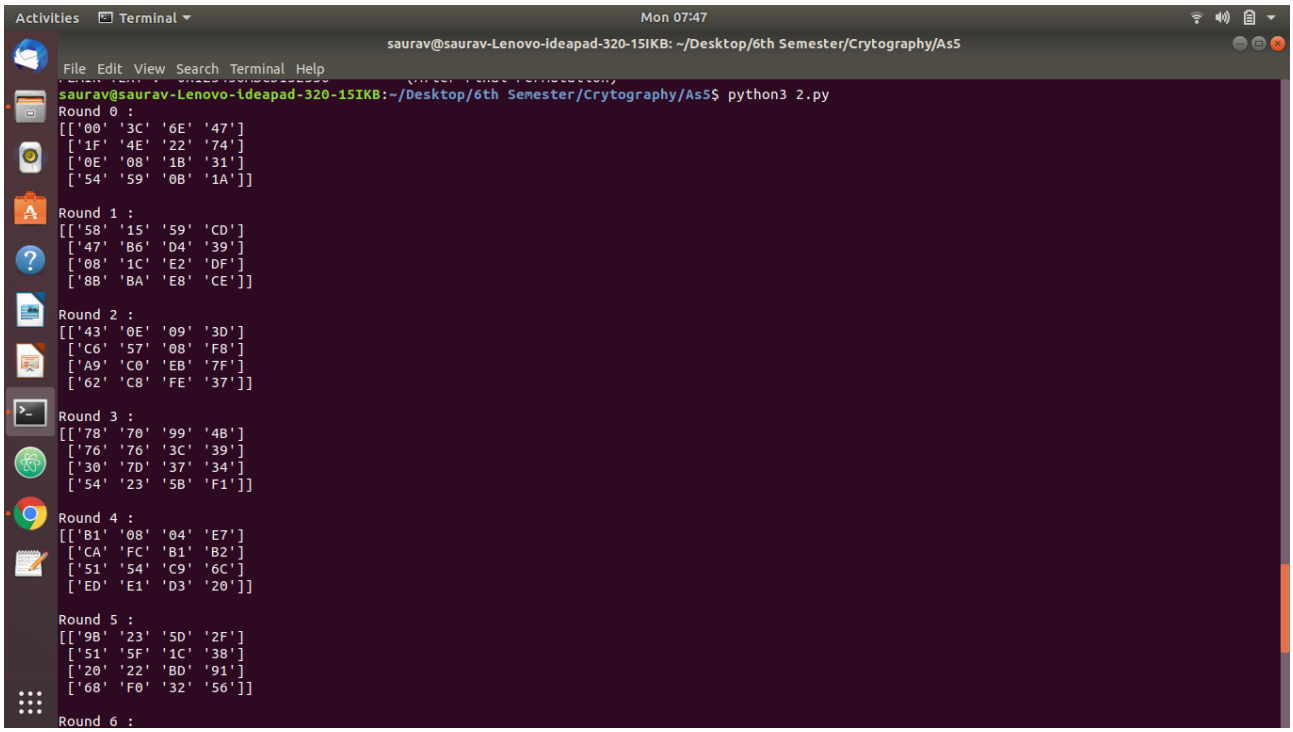
```
import numpy as np
s_box = [
    [0x63, 0x7C, 0x77, 0x7B, 0xF2, 0x6B, 0x6F, 0xC5, 0x30, 0x01, 0x67, 0x2B, 0xFE, 0xD7,
0xAB, 0x76],
    [0xCA, 0x82, 0xC9, 0x7D, 0xFA, 0x59, 0x47, 0xF0, 0xAD, 0xD4, 0xA2, 0xAF, 0x9C, 0xA4,
0x72, 0xC0],
    [0xB7, 0xFD, 0x93, 0x26, 0x36, 0x3F, 0xF7, 0xCC, 0x34, 0xA5, 0xE5, 0xF1, 0x71, 0xD8, 0x31,
0x15],
    [0x04, 0xC7, 0x23, 0xC3, 0x18, 0x96, 0x05, 0x9A, 0x07, 0x12, 0x80, 0xE2, 0xEB, 0x27, 0xB2,
0x75],
    [0x09, 0x83, 0x2C, 0x1A, 0x1B, 0x6E, 0x5A, 0xA0, 0x52, 0x3B, 0xD6, 0xB3, 0x29, 0xE3,
0x2F, 0x84],
    [0x53, 0xD1, 0x00, 0xED, 0x20, 0xFC, 0xB1, 0x5B, 0x6A, 0xCB, 0xBE, 0x39, 0x4A, 0x4C,
0x58, 0xCF],
    [0xD0, 0xEF, 0xAA, 0xFB, 0x43, 0x4D, 0x33, 0x85, 0x45, 0xF9, 0x02, 0x7F, 0x50, 0x3C, 0x9F,
0xA8],
    [0x51, 0xA3, 0x40, 0x8F, 0x92, 0x9D, 0x38, 0xF5, 0xBC, 0xB6, 0xDA, 0x21, 0x10, 0xFF, 0xF3,
0xD2],
    [0xCD, 0x0C, 0x13, 0xEC, 0x5F, 0x97, 0x44, 0x17, 0xC4, 0xA7, 0x7E, 0x3D, 0x64, 0x5D,
0x19, 0x73],
    [0x60, 0x81, 0x4F, 0xDC, 0x22, 0x2A, 0x90, 0x88, 0x46, 0xEE, 0xB8, 0x14, 0xDE, 0x5E,
0x0B, 0xDB],
    [0xE0, 0x32, 0x3A, 0x0A, 0x49, 0x06, 0x24, 0x5C, 0xC2, 0xD3, 0xAC, 0x62, 0x91, 0x95,
0xE4, 0x79],
    [0xE7, 0xC8, 0x37, 0x6D, 0x8D, 0xD5, 0x4E, 0xA9, 0x6C, 0x56, 0xF4, 0xEA, 0x65, 0x7A,
0xAE, 0x08],
    [0xBA, 0x78, 0x25, 0x2E, 0x1C, 0xA6, 0xB4, 0xC6, 0xE8, 0xDD, 0x74, 0x1F, 0x4B, 0xBD,
0x8B, 0x8A],
    [0x70, 0x3E, 0xB5, 0x66, 0x48, 0x03, 0xF6, 0x0E, 0x61, 0x35, 0x57, 0xB9, 0x86, 0xC1, 0x1D,
0x9E],
    [0xE1, 0xF8, 0x98, 0x11, 0x69, 0xD9, 0x8E, 0x94, 0x9B, 0x1E, 0x87, 0xE9, 0xCE, 0x55, 0x28,
0xDF],
    [0x8C, 0xA1, 0x89, 0x0D, 0xBF, 0xE6, 0x42, 0x68, 0x41, 0x99, 0x2D, 0x0F, 0xB0, 0x54, 0xBB,
0x16],
]
r_const=["01","02","04","08","10","20","40","80","1B","36"]
constant=['2','3','1','1','1','2','3','1','1','1','2','3','3','1','1','2']
constant=np.array(constant).reshape(4,4)

def multiply(p1,p2):
        p2=('{0:08b}'.format(p2))
        p1=('{0:08b}'.format(p1))
        mod="100011011"
```

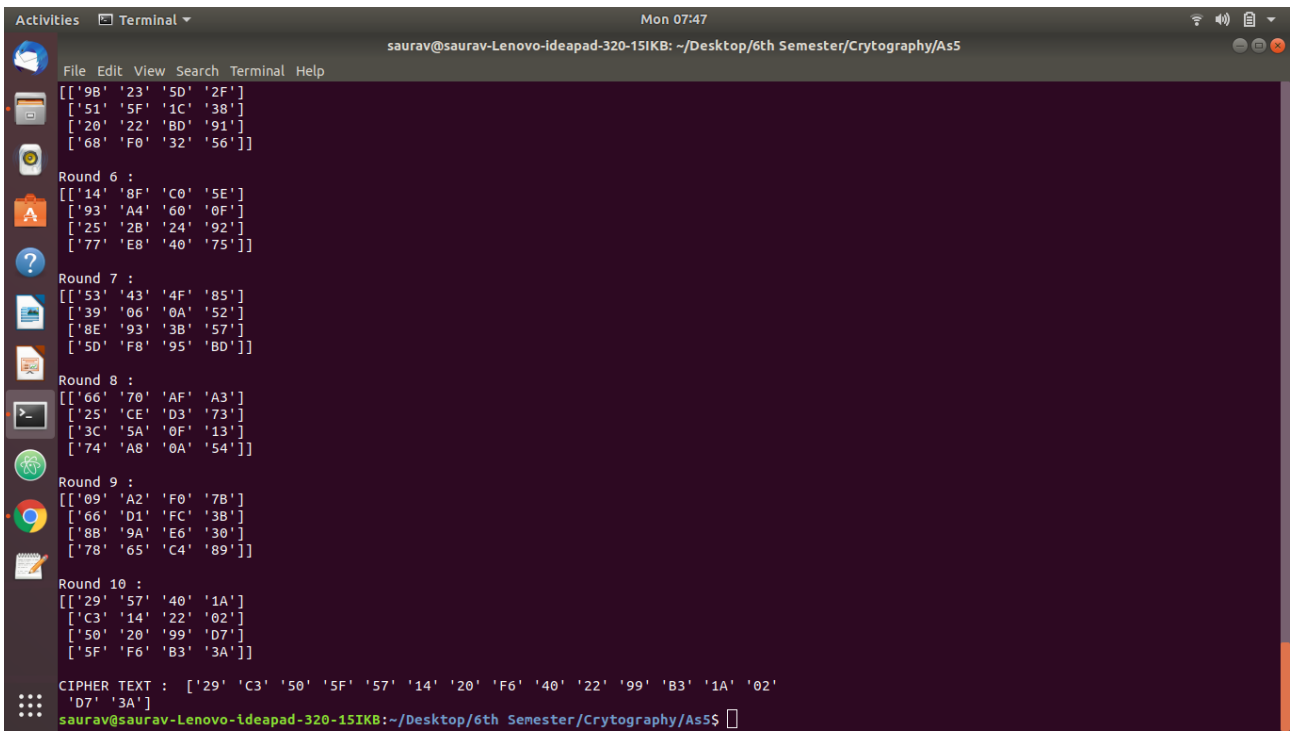
```
        result="0"
        p2="0"+p2
        p1= "".join(reversed(p1))
        if(p1[0]=="1"):
                result=p2[1:]
        for i in range(1,len(p1)):
                p2=p2[1:]+"0"
                if(p2[0]=="1"):
                        p2 = int(p2,2) ^ int(mod,2)
                        p2=('{0:09b}'.format(p2))
                if(p1[i]=="1"):
                        result=int(p2,2) ^ int(result,2)
                        result=('{0:08b}'.format(result))
        return result

def xor(x,y):
        state=["  "]*16
        state=np.array(state).reshape(4,4)
        for i in range(4):
                for j in range(4):
                        temp=int(x[i][j],16) ^ int(y[i][j],16)
                        state[i][j]=('{0:02x}'.format(temp)).upper()
        return state

def xor1(x,y):
        state=["  "]*4
        for i in range(4):
                temp=int(x[i],16) ^ int(y[i],16)
                state[i]=('{0:02x}'.format(temp)).upper()
        return state

def sub(text):
        for i in range(4):
                for j in range(4):
                        x=int(text[i][j][0],16)
                        y=int(text[i][j][1],16)
                        temp=s_box[x][y]
                        text[i][j]=('{0:02x}'.format(temp)).upper()
        return text

def shift(text):
        i=0
        for row in text:
                text[i]=np.roll(row,-i)
                i=i+1
        return text

def mix(text):
        result=["00"]*16
        result=np.array(result).reshape(4,4)
        for i in range(4):
                for j in range(4):
```

```
                        for k in range(4):
                                temp = int(result[i][j],16) ^ int(multiply(int(constant[i]
[k],16),int(text[k][j],16)),2)
                                result[i][j]=('{0:02x}'.format(temp)).upper()
        return result

def hex_gen(text):
        while(len(text) < 16):
                text=text+"z"
        if(len(text)>16):
                text=text[:16]
        new_text=[]
        for i in text:
                temp=(ord(i))
                temp=('{0:02x}'.format(temp)).upper()
                new_text.append(temp)
        text_array=np.array(new_text).reshape(4,4).transpose()
        return text_array

def state_gen(text,i):
        text=sub(text)
        text=shift(text)
        if(i != 9):
                text=mix(text)
        return text

def key_gen(key,index):
        key=np.array(key).transpose()
        temp=np.roll(key[3],-1)
        for i in range(4):
                x=int(temp[i][0],16)
                y=int(temp[i][1],16)
                temp1=s_box[x][y]
                temp[i]=('{0:02x}'.format(temp1)).upper()
        temp2=int(temp[0],16) ^ int(r_const[index],16)
        temp[0]=('{0:02x}'.format(temp2)).upper()
        for i in range(4):
                key[i]=xor1(key[i],temp)
                temp=key[i]
        key=np.array(key).transpose()
        return key

def aes(text,key):
        key=hex_gen(key)
        text=hex_gen(text)
        state=xor(text,key)
        print("Round 0 :")
        print(state)
        for i in range(10):
                state=state_gen(state,i)
                key=key_gen(key,i)
                #print(key)
```

```
            state=xor(state,key)
            print("\nRound",i+1,":")
            print(state)
        state=np.array(state).transpose()
        state=np.array(state).reshape(16)
        return state

key="Thats my Kung Fu"
text="Two One Nine Two"
cipher=aes(text,key)
text=""
for i in cipher:
        text+=chr(int(i,16))
print("\nCIPHER TEXT : ",cipher)
```

OUTPUT:

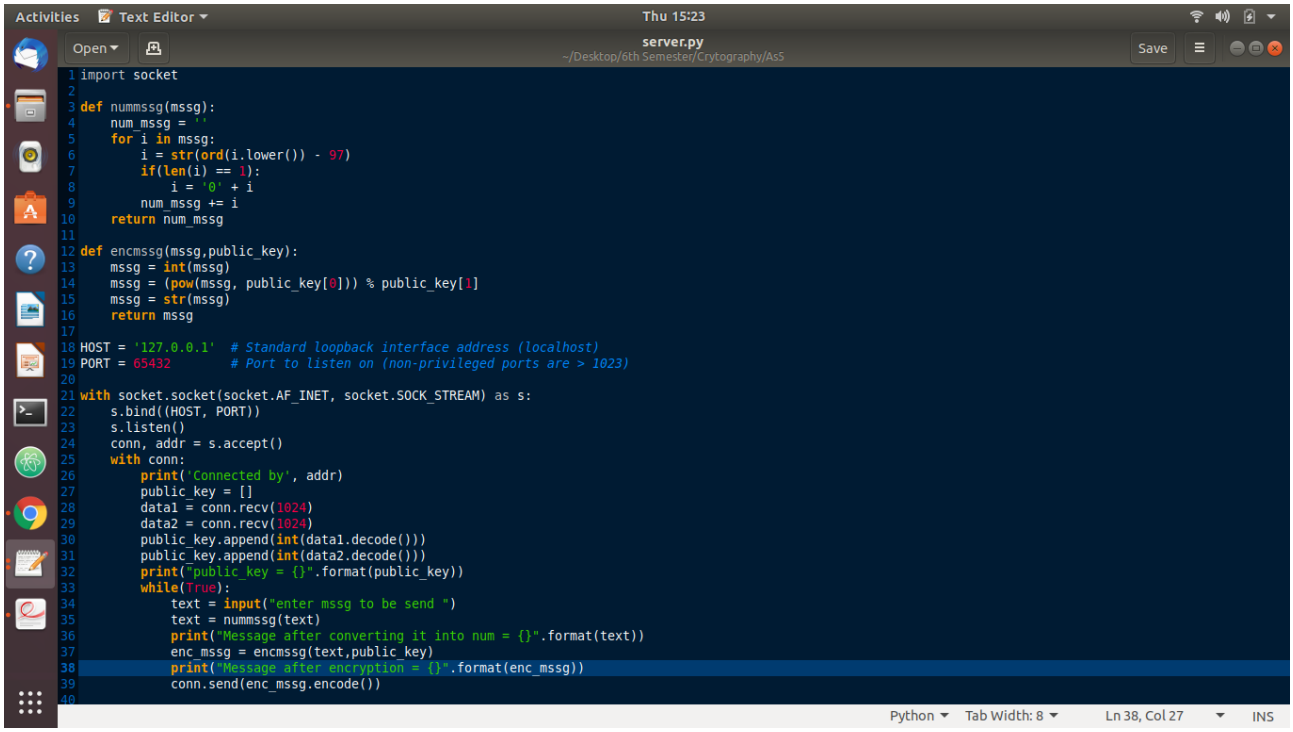




Q2.

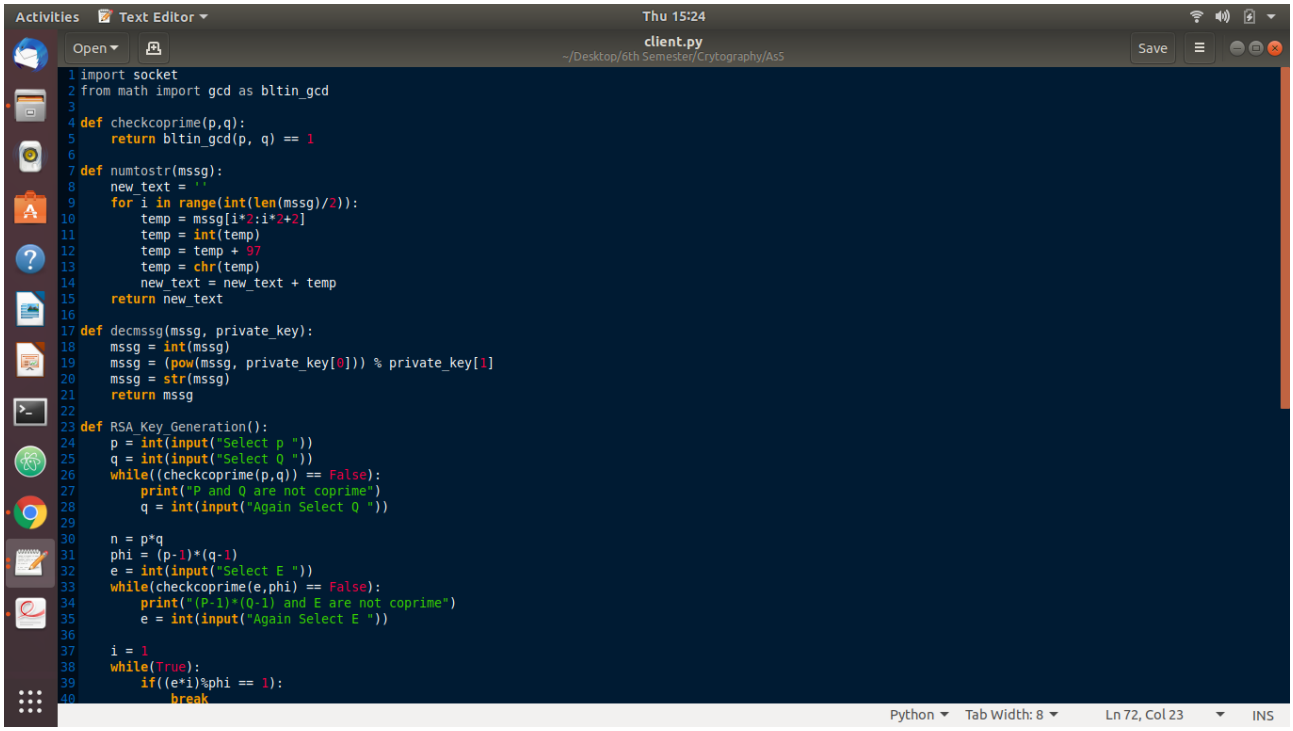
RSA

PROGRAM CODE (Server Side):

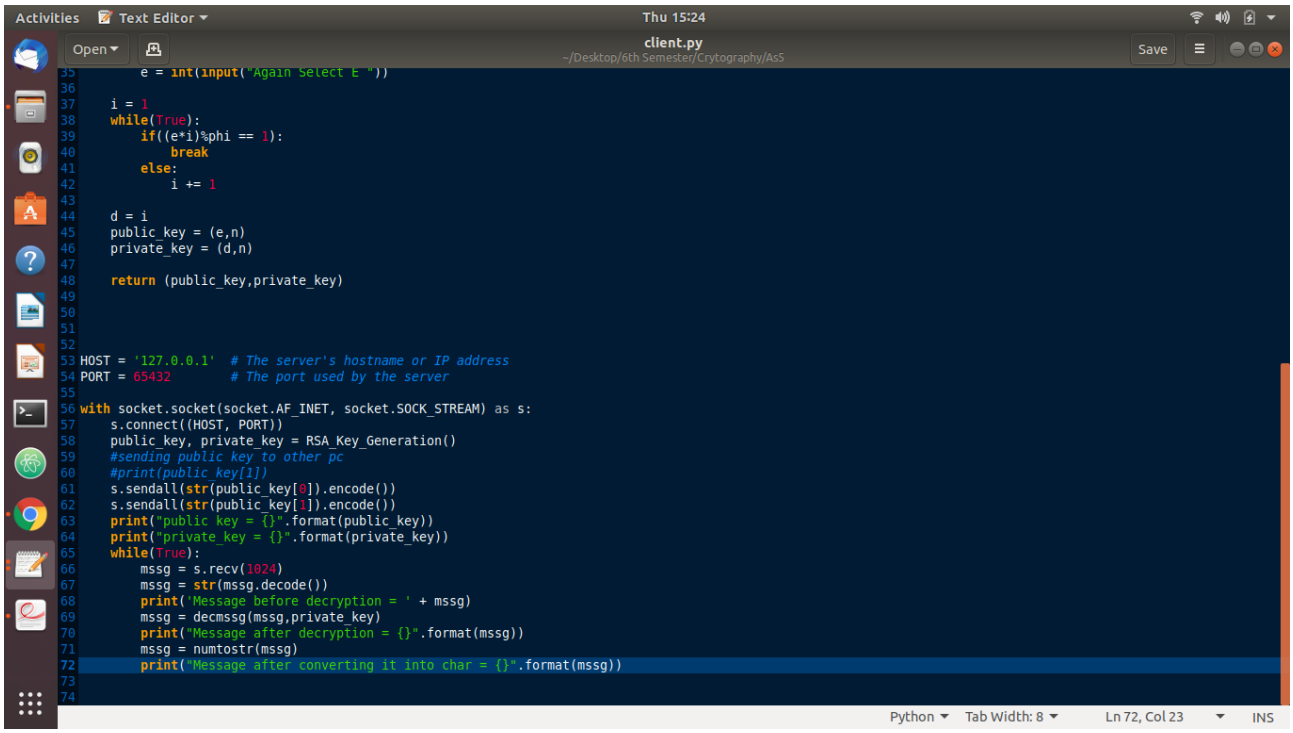



```python
import socket

def nummssg(mssg):
    num_mssg = ''
    for i in mssg:
        i = str(ord(i.lower()) - 97)
        if(len(i) == 1):
            i = '0' + i
        num_mssg += i
    return num_mssg

def encmssg(mssg,public_key):
    mssg = int(mssg)
    mssg = (pow(mssg, public_key[0])) % public_key[1]
    mssg = str(mssg)
    return mssg

HOST = '127.0.0.1'  # Standard loopback interface address (localhost)
PORT = 65432        # Port to listen on (non-privileged ports are > 1023)

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.bind((HOST, PORT))
    s.listen()
    conn, addr = s.accept()
    with conn:
        print('Connected by', addr)
        public_key = []
        data1 = conn.recv(1024)
        data2 = conn.recv(1024)
        public_key.append(int(data1.decode()))
        public_key.append(int(data2.decode()))
        print("public_key = {}".format(public_key))
        while(True):
            text = input("enter mssg to be send ")
            text = nummssg(text)
            print("Message after converting it into num = {}".format(text))
            enc_mssg = encmssg(text,public_key)
            print("Message after encryption = {}".format(enc_mssg))
            conn.send(enc_mssg.encode())
```

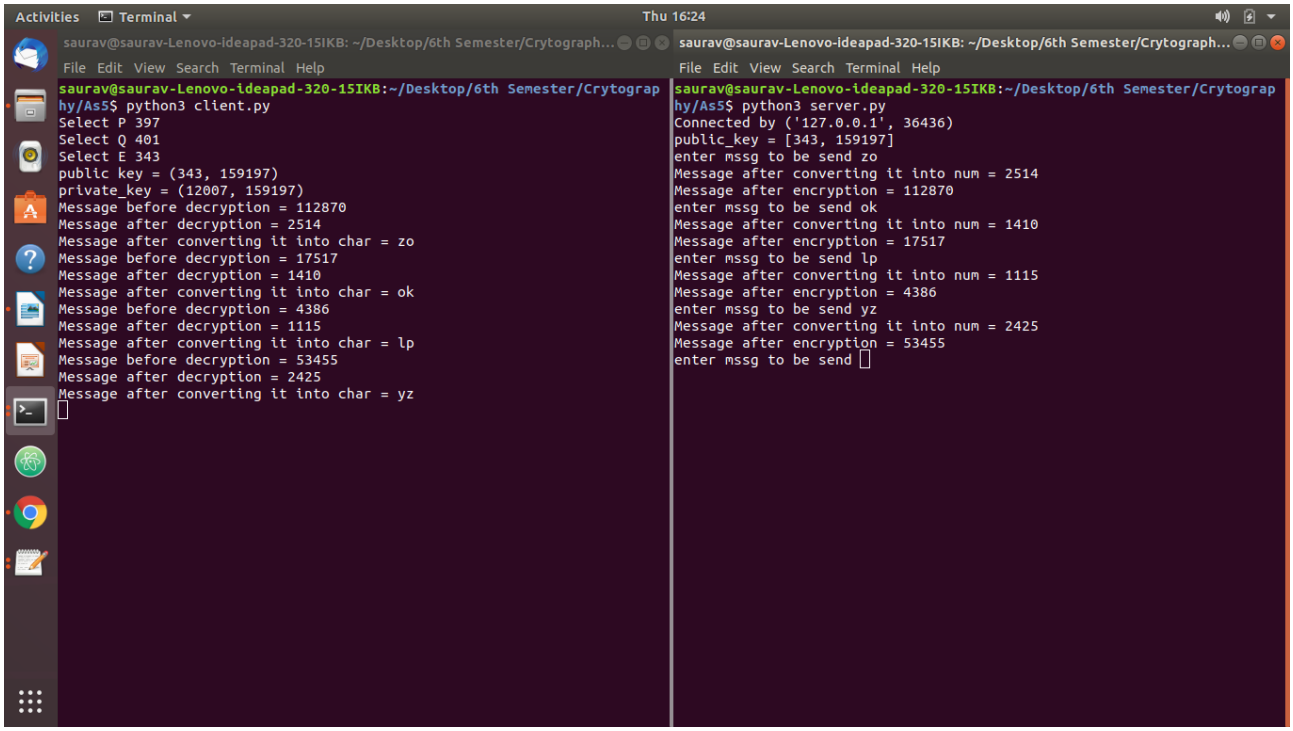
PROGRAM CODE (Client Side):




```python
import socket
from math import gcd as bltin_gcd

def checkcoprime(p,q):
    return bltin_gcd(p, q) == 1

def numtostr(mssg):
    new_text = ''
    for i in range(int(len(mssg)/2)):
        temp = mssg[i*2:i*2+2]
        temp = int(temp)
        temp = temp + 97
        temp = chr(temp)
        new_text = new_text + temp
    return new_text

def decmssg(mssg, private_key):
    mssg = int(mssg)
    mssg = (pow(mssg, private_key[0])) % private_key[1]
    mssg = str(mssg)
    return mssg

def RSA_Key_Generation():
    p = int(input("Select p "))
    q = int(input("Select Q "))
    while((checkcoprime(p,q)) == False):
        print("P and Q are not coprime")
        q = int(input("Again Select Q "))

    n = p*q
    phi = (p-1)*(q-1)
    e = int(input("Select E "))
    while(checkcoprime(e,phi) == False):
        print("(P-1)*(Q-1) and E are not coprime")
        e = int(input("Again Select E "))

    i = 1
    while(True):
        if((e*i)%phi == 1):
            break
```


Activities
Text Editor
Thu 15:24
Open
client.py
~/Desktop/6th Semester/Crytography/As5
Save
e = int(input("Again Select E "))
i = 1
while(True):
if((e*i)%phi == 1):
break
else:
i += 1
d = i
public_key = (e,n)
private_key = (d,n)
return (public_key,private_key)
HOST = '127.0.0.1' # The server's hostname or IP address
PORT = 65432 # The port used by the server
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
s.connect((HOST, PORT))
public_key, private_key = RSA_Key_Generation()
#sending public key to other pc
#print(public_key[1])
s.sendall(str(public_key[0]).encode())
s.sendall(str(public_key[1]).encode())
print("public key = {}".format(public_key))
print("private key = {}".format(private_key))
while(True):
mssg = s.recv(1024)
mssg = str(mssg.decode())
print('Message before decryption = ' + mssg)
mssg = decmssg(mssg,private_key)
print("Message after decryption = {}".format(mssg))
mssg = numtostr(mssg)
print("Message after converting it into char = {}".format(mssg))
Python
Tab Width: 8
Ln 72, Col 23
INS

OUTPUT:


Activities
Terminal
Thu 16:24
saurav@saurav-Lenovo-ideapad-320-15IKB: ~/Desktop/6th Semester/Crytograph...
File Edit View Search Terminal Help
saurav@saurav-Lenovo-ideapad-320-15IKB:~/Desktop/6th Semester/Crytography/As5$ python3 client.py
Select P 397
Select Q 401
Select E 343
public key = (343, 159197)
private_key = (12007, 159197)
Message before decryption = 112870
Message after decryption = 2514
Message after converting it into char = zo
Message before decryption = 17517
Message after decryption = 1410
Message after converting it into char = ok
Message before decryption = 4386
Message after decryption = 1115
Message after converting it into char = lp
Message before decryption = 53455
Message after decryption = 2425
Message after converting it into char = yz
saurav@saurav-Lenovo-ideapad-320-15IKB: ~/Desktop/6th Semester/Crytograph...
File Edit View Search Terminal Help
saurav@saurav-Lenovo-ideapad-320-15IKB:~/Desktop/6th Semester/Crytography/As5$ python3 server.py
Connected by ('127.0.0.1', 36436)
public_key = [343, 159197]
enter mssg to be send zo
Message after converting it into num = 2514
Message after encryption = 112870
enter mssg to be send ok
Message after converting it into num = 1410
Message after encryption = 17517
enter mssg to be send lp
Message after converting it into num = 1115
Message after encryption = 4386
enter mssg to be send yz
Message after converting it into num = 2425
Message after encryption = 53455
enter mssg to be send

Q4.

RSA
(Digital Signature)

SCREENSHOT: