Name :- Harsh Shah

Class:- TE Computer

ERP :-67

Subject :-LP2(AI) (BFS and DFS)

Code:-

```
import collections

# DFS algorithm
def dfs(graph, start, visited=None):
    if visited is None:
        visited = set()
    visited.add(start)

    print(start)

    for next in graph[start] - visited:
        dfs(graph, next, visited)
    return visited

# BFS algorithm
def bfs(graph, root):

    visited, queue = set(), collections.deque([root])
    visited.add(root)

    while queue:

        # Dequeue a vertex from queue
        vertex = queue.popleft()
        print(str(vertex) + " ", end="")

        # If not visited, mark it as visited, and
        # enqueue it
        for neighbour in graph[vertex]:
            if neighbour not in visited:
                visited.add(neighbour)
                queue.append(neighbour)

vertex = []
Connections = []

no_vertex = int(input("Enter total number of vertex : "))
start_vertex = int(input("Enter starting vertex : "))

for i in range(no_vertex):
    vertex_n = int(input("Enter vertex " + str(i + 1) + " : "))
    # creating an empty list
    vertex.append(vertex_n)
    temp = []


    # number of elements as input
    n = int(input("Enter number of connections : "))

    # iterating till the range
    for i in range(0, n):
        ele = int(input("Enter connected to " + str(vertex_n) + " : "))
        temp.append(ele)  # adding the element

    print(temp)
    Connections.append(temp)


print(vertex)
print(Connections)
graph={ vertex[i]:Connections[i] for i in range(no_vertex)}
graph_dfs = {vertex[i]:set(Connections[i]) for i in range(no_vertex)}
print(graph)


flag = 1
while flag == 1:
    print("/*************MENU**************/")
    print("1. DFS")
    print("2. BFS ")
    print("3. Exit ")
    choice = int(input("Enter your choice : "))

    if choice == 1:
        print("Following is DFS :")
        print(dfs(graph_dfs, start_vertex))
    elif choice == 2:
        print("Following is BFS : " )
        print(bfs(graph, start_vertex))
    elif choice == 3:
        print("Exit")
        flag = 0
    else:
        print("Wrong Choice,Please Choose Another Option.")
```

Output:-

```
Enter total number of vertex : 4

Enter starting vertex : 2

Enter vertex 1 : 0

Enter number of connections : 2

Enter connected to 0 : 1

Enter connected to 0 : 2

[1, 2]

Enter vertex 2 : 1

Enter number of connections : 1

Enter connected to 1 : 2

[2]

Enter vertex 3 : 2

Enter number of connections : 2

Enter connected to 2 : 0

Enter connected to 2 : 3

[0, 3]

Enter vertex 4 : 3

Enter number of connections : 1

Enter connected to 3 : 3

[3]

[0, 1, 2, 3]

[[1, 2], [2], [0, 3], [3]]

{0: [1, 2], 1: [2], 2: [0, 3], 3: [3]}

/*************MENU**************/

1. DFS

2. BFS

3. Exit

Enter your choice : 1

Following is DFS :

2
```

```
0
1
3
/*************MENU**************/
1. DFS
2. BFS
3. Exit
Enter your choice : 2
Following is BFS :
2 0 3 1
/*************MENU**************/
1. DFS
2. BFS
3. Exit
Enter your choice : 5
Wrong Choice,Please Choose Another Option.
/*************MENU**************/
1. DFS
2. BFS
3. Exit
Enter your choice : 3
Exit

Process finished with exit code 0
```

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

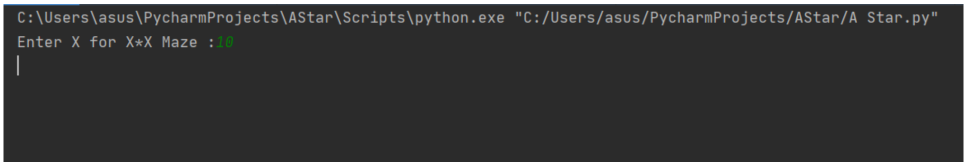
Subject :-LP2(AI) (A Star)

Code:-

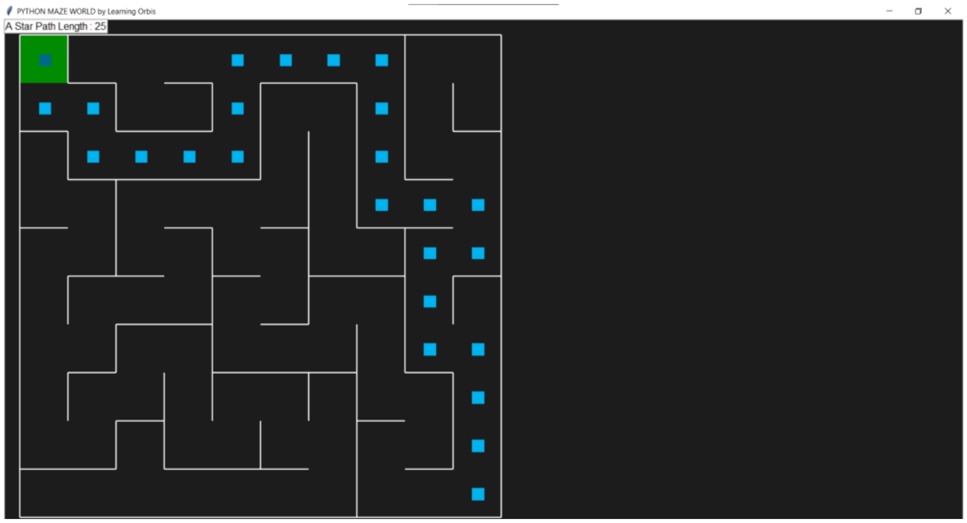
```
from pyamaze import maze,agent,textLabel
from queue import PriorityQueue
def h(cell1,cell2):
    x1,y1=cell1
    x2,y2=cell2

    return abs(x1-x2) + abs(y1-y2)
def aStar(m):
    start=(m.rows,m.cols)
    g_score={cell:float('inf') for cell in m.grid}
    g_score[start]=0
    f_score={cell:float('inf') for cell in m.grid}
    f_score[start]=h(start,(1,1))

    open=PriorityQueue()
    open.put((h(start,(1,1)),h(start,(1,1)),start))
    aPath={}
    while not open.empty():
        currCell=open.get()[2]
        if currCell==(1,1):
            break
        for d in 'ESNW':
            if m.maze_map[currCell][d]==True:
                if d=='E':
                    childCell=(currCell[0],currCell[1]+1)
                if d=='W':
                    childCell=(currCell[0],currCell[1]-1)
                if d=='N':
                    childCell=(currCell[0]-1,currCell[1])
                if d=='S':
                    childCell=(currCell[0]+1,currCell[1])

                temp_g_score=g_score[currCell]+1
                temp_f_score=temp_g_score+h(childCell,(1,1))

                if temp_f_score < f_score[childCell]:
                    g_score[childCell]= temp_g_score
                    f_score[childCell]= temp_f_score
                    open.put((temp_f_score,h(childCell,(1,1)),childCell))
                    aPath[childCell]=currCell
    fwdPath={}
    cell=(1,1)
    while cell!=start:
        fwdPath[aPath[cell]]=cell
        cell=aPath[cell]
    return fwdPath

if __name__=='__main__':
    x = int(input("Enter X for X*X Maze :"))
    m=maze(x,x)
    m.CreateMaze()
    path=aStar(m)

    a=agent(m,footprints=True)
    m.tracePath({a:path})
    l=textLabel(m,'A Star Path Length',len(path)+1)

    m.run()
```

Output:-

Enter X for X*X Maze :10



```
C:\Users\asus\PycharmProjects\AStar\Scripts\python.exe "C:/Users/asus/PycharmProjects/AStar/A Star.py"
Enter X for X*X Maze :10
```



A Star Path Length : 25

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

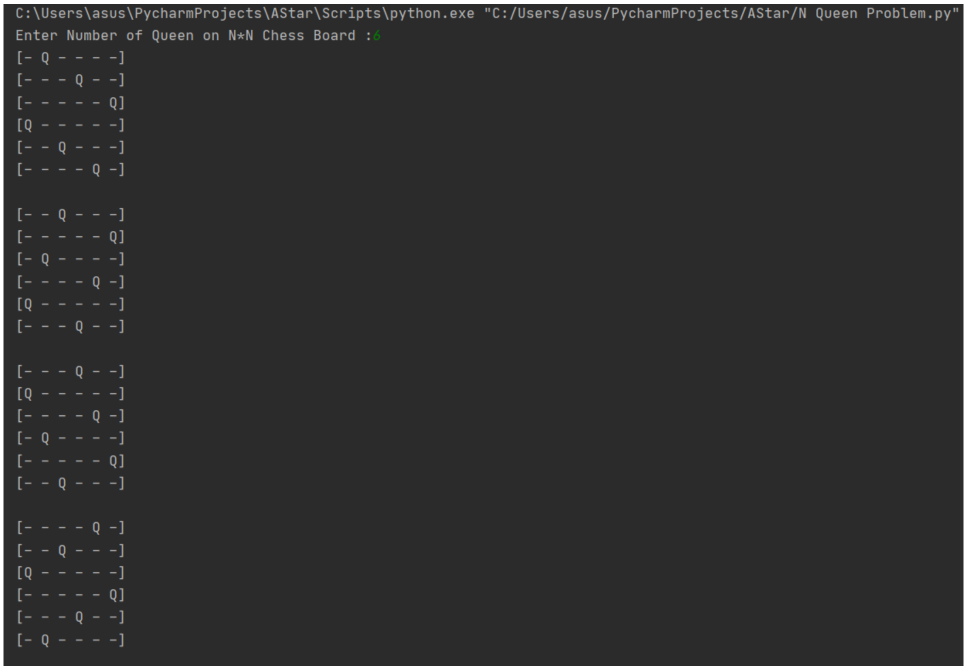
Subject :-LP2(AI) (N Queens)

Code:-

```
# Function to check if two queens threaten each other or not
def isSafe(mat, r, c):
    # return false if two queens share the same column
    for i in range(r):
        if mat[i][c] == 'Q':
            return False

    # return false if two queens share the same `` diagonal
    (i, j) = (r, c)
    while i >= 0 and j >= 0:
        if mat[i][j] == 'Q':
            return False
        i = i - 1
        j = j - 1

    # return false if two queens share the same `/` diagonal4
    (i, j) = (r, c)
    while i >= 0 and j < len(mat):
        if mat[i][j] == 'Q':
            return False
        i = i - 1
        j = j + 1

    return True


def printSolution(mat):
    for r in mat:
        print(str(r).replace(',', '').replace('\'', ''))
    print()


def nQueen(mat, r):
    # if `N` queens are placed successfully, print the solution
    if r == len(mat):
        printSolution(mat)
        return

    # place queen at every square in the current row `r`
    # and recur for each valid movement
    for i in range(len(mat)):
        # if no two queens threaten each other
        if isSafe(mat, r, i):
            # place queen on the current square
            mat[r][i] = 'Q'

            # recur for the next row
            nQueen(mat, r + 1)

            # backtrack and remove the queen from the current square
            mat[r][i] = '–'


if __name__ == '__main__':
    # `N × N` chessboard
    N = int(input("Enter Number of Queen on N*N Chess Board :"))

    # `mat[][]` keeps track of the position of queens in
    # the current configuration
    mat = [['–' for x in range(N)] for y in range(N)]

    nQueen(mat, 0)
```

Output:-

```
Enter Number of Queen on N*N Chess Board :6
[– Q – – – –]
[– – – Q – –]
[– – – – – Q]
[Q – – – – –]
[– – Q – – –]
[– – – – Q –]


[– – Q – – –]
[– – – – – Q]
[– Q – – – –]
[– – – – Q –]
[Q – – – – –]
[– – – Q – –]
[– – – Q – –]
[Q – – – – –]
[– – – – Q –]
[– Q – – – –]
[– – – – – Q]
[– – Q – – –]

[– – – – Q –]
[– – Q – – –]
[Q – – – – –]
[– – – – – Q]
[– – – Q – –]
[– Q – – – –]
```



```
C:\Users\asus\PycharmProjects\AStar\Scripts\python.exe "C:/Users/asus/PycharmProjects/AStar/N Queen Problem.py"
Enter Number of Queen on N*N Chess Board :6
[- Q - - - -]
[- - - Q - -]
[- - - - - Q]
[Q - - - - -]
[- - Q - - -]
[- - - - Q -]

[- - Q - - -]
[- - - - - Q]
[- Q - - - -]
[- - - - Q -]
[Q - - - - -]
[- - - Q - -]

[- - - Q - -]
[Q - - - - -]
[- - - - Q -]
[- Q - - - -]
[- - - - - Q]
[- - Q - - -]

[- - - - Q -]
[- - Q - - -]
[Q - - - - -]
[- - - - - Q]
[- - - Q - -]
[- Q - - - -]
```

Name :- Harsh Shah

Class:- TE Computer

ERP :-67

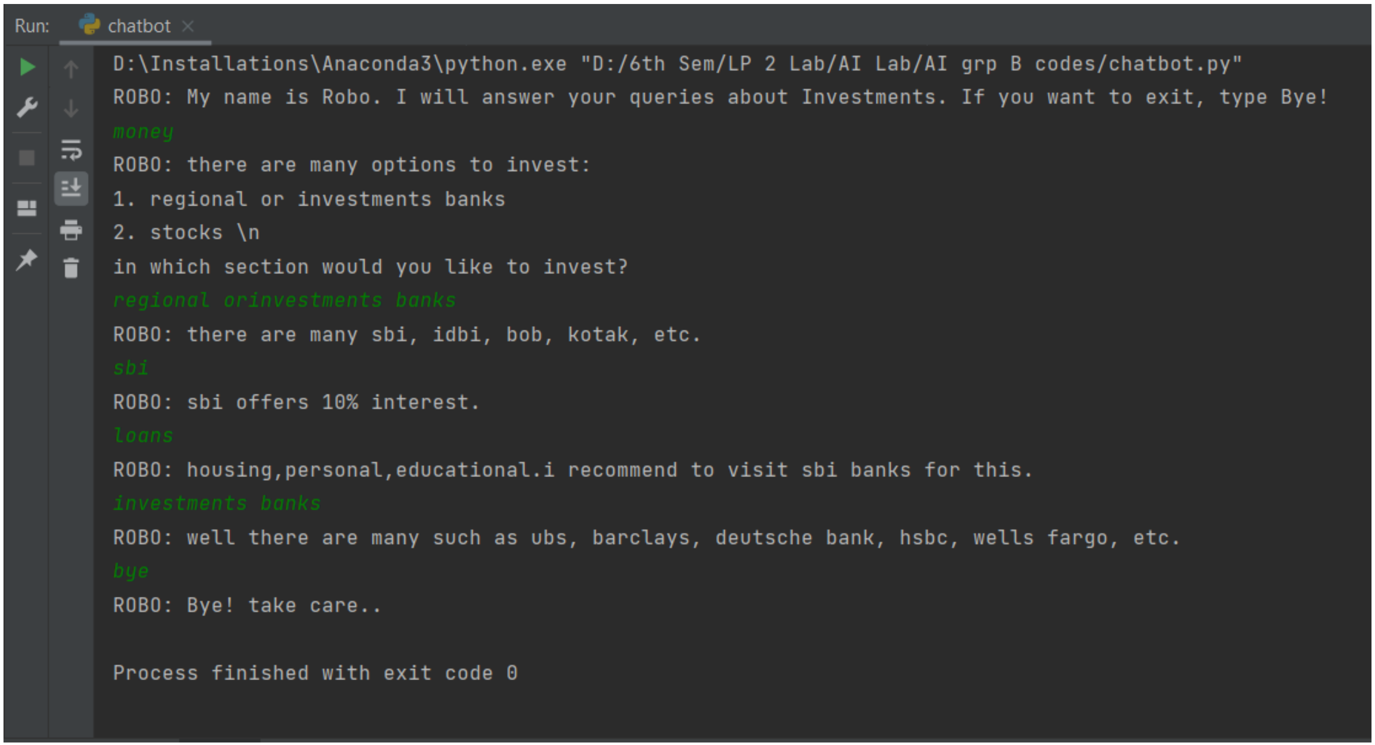
Subject :-LP2(AI) (Chatbot)

Code:-

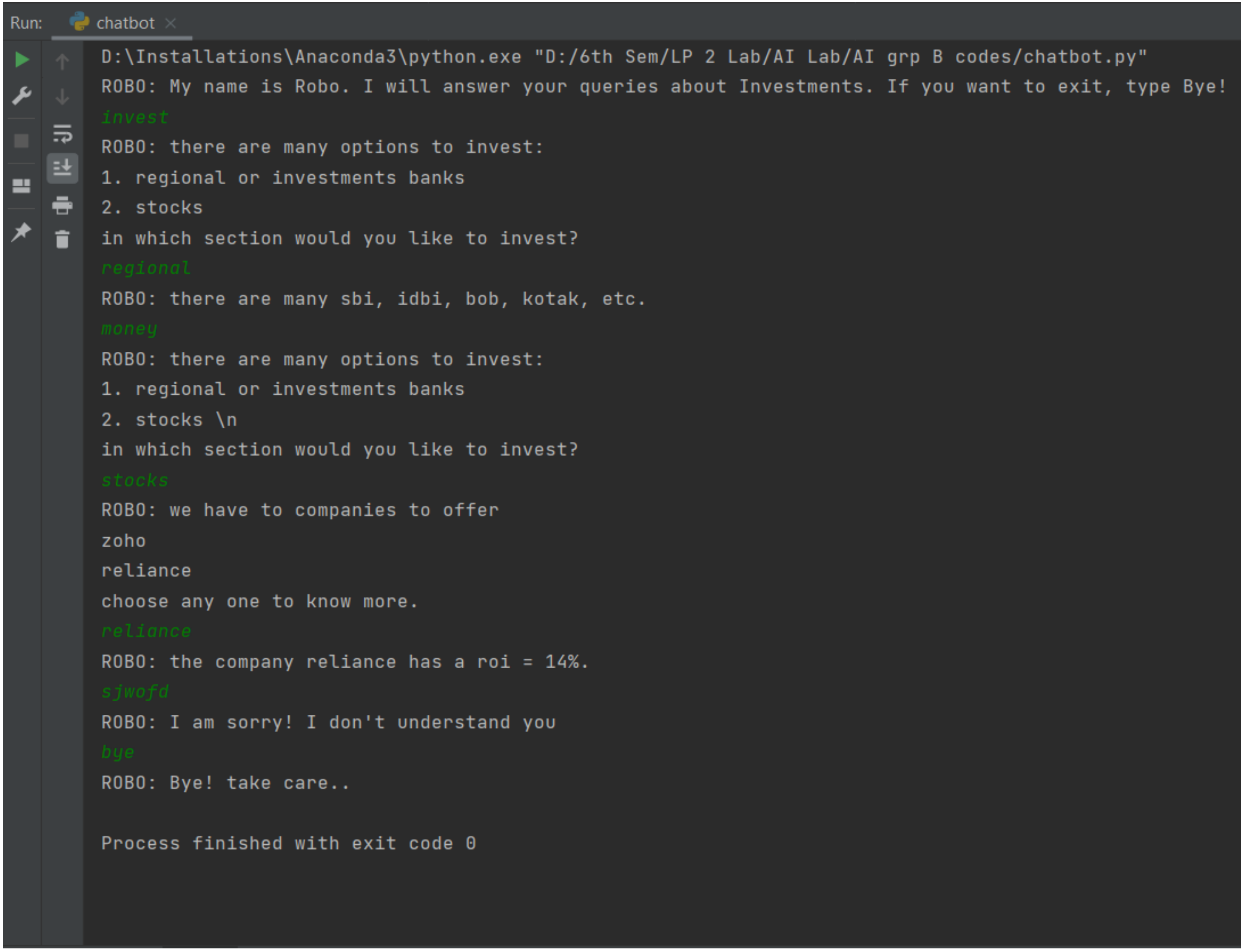
```
import io
import random
import string
import warnings
import numpy as np
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics.pairwise import cosine_similarity
import warnings
warnings.filterwarnings('ignore')
import nltk
from nltk.stem import WordNetLemmatizer
# nltk.download('popular', quiet=True)
# nltk.download('punkt')
# nltk.download('wordnet')

with open('chatbot.txt','r', encoding='utf8', errors ='ignore') as fin:
    raw = fin.read().lower()

#Tokenisation
sent_tokens = nltk.sent_tokenize(raw)
word_tokens = nltk.word_tokenize(raw)

# Preprocessing
lemmer = WordNetLemmatizer()
def LemTokens(tokens):
    return [lemmer.lemmatize(token) for token in tokens]
remove_punct_dict = dict((ord(punct), None) for punct in string.punctuation)
def LemNormalize(text):
    return LemTokens(nltk.word_tokenize(text.lower().translate(remove_punct_dict)))


# Keyword Matching
GREETING_INPUTS = ("hello", "hi", "greetings", "sup", "what's up","hey","Helo")
GREETING_RESPONSES = ["hi", "hey", "hi there", "hello", "I am glad! You are talking to me"]

def greeting(sentence):
    for word in sentence.split():
        if word.lower() in GREETING_INPUTS:
            return random.choice(GREETING_RESPONSES)
```

```
def response(user_response):
    robo_response="
    sent_tokens.append(user_response)
    TfidfVec = TfidfVectorizer(tokenizer=LemNormalize, stop_words='english')
    tfidf = TfidfVec.fit_transform(sent_tokens)
    vals = cosine_similarity(tfidf[-1], tfidf)
    idx=vals.argsort()[0][-2]
    flat = vals.flatten()
    flat.sort()
    req_tfidf = flat[-2]
    if(req_tfidf==0):
        robo_response=robo_response+"I am sorry! I don't understand you"
        return robo_response
    else:
        robo_response = robo_response+sent_tokens[idx]
        return robo_response

flag=True
print("ROBO: My name is Robo. I will answer your queries about Investments. If you want to exit, type Bye!")
while(flag==True):
    user_response = input()
    user_response=user_response.lower()
    if(user_response!='bye'):
        if(user_response=='thanks' or user_response=='thank you' ):
            flag=False
            print("ROBO: You are welcome..")
        else:
            if(greeting(user_response)!=None):
                print("ROBO: "+greeting(user_response))
            else:
                print("ROBO: ",end="")
                res = response(user_response)
                nlines = res.count('\n')
                if nlines > 0:
                    res = res.split("\n",1)[1]
                print(res)
                sent_tokens.remove(user_response)
    else:
        flag=False
        print("ROBO: Bye! take care..")
```

Output:-



```
D:\Installations\Anaconda3\python.exe "D:/6th Sem/LP 2 Lab/AI Lab/AI grp B codes/chatbot.py"
ROBO: My name is Robo. I will answer your queries about Investments. If you want to exit, type Bye!
money
ROBO: there are many options to invest:
1. regional or investments banks
2. stocks \n
in which section would you like to invest?
regional orinvestments banks
ROBO: there are many sbi, idbi, bob, kotak, etc.
sbi
ROBO: sbi offers 10% interest.
loans
ROBO: housing,personal,educational.i recommend to visit sbi banks for this.
investments banks
ROBO: well there are many such as ubs, barclays, deutsche bank, hsbc, wells fargo, etc.
bye
ROBO: Bye! take care..

Process finished with exit code 0
```



```
D:\Installations\Anaconda3\python.exe "D:/6th Sem/LP 2 Lab/AI Lab/AI grp B codes/chatbot.py"
ROBO: My name is Robo. I will answer your queries about Investments. If you want to exit, type Bye!
invest
ROBO: there are many options to invest:
1. regional or investments banks
2. stocks
in which section would you like to invest?
regional
ROBO: there are many sbi, idbi, bob, kotak, etc.
money
ROBO: there are many options to invest:
1. regional or investments banks
2. stocks \n
in which section would you like to invest?
stocks
ROBO: we have to companies to offer
zoho
reliance
choose any one to know more.
reliance
ROBO: the company reliance has a roi = 14%.
sjwofd
ROBO: I am sorry! I don't understand you
bye
ROBO: Bye! take care..

Process finished with exit code 0
```

Name :- Harsh Shah

Class:- TE Computer

ERP :-67

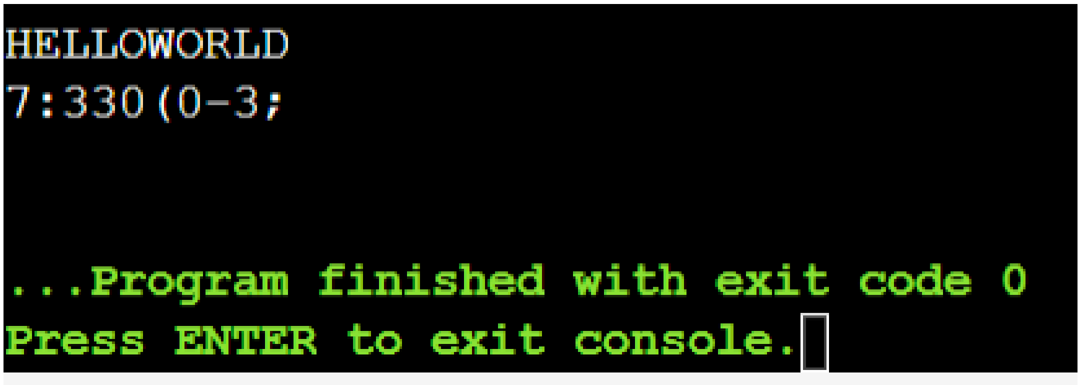
Subject :-LP2(IS) (Logical Operations)

Code:-

```
#include <iostream.h>
//using namespace std;
#include <stdio.h>
#include <conio.h>
#include <string.h>
#include <stdlib.h>
void main()
{
   //clrscr();
   char str[]="HELLOWORLD";
   char str1[11];
   char str2[11];
   int i,len;
   len = strlen(str);

   for(i=0;i<len;i++)
   {
      str1[i]=str[i] & 127;
      cout<<str1[i];
   }
   cout<<"\n";
   for(i=0;i<len;i++)
   {
      str2[i] = str[i] ^ 127;
      cout<<str2[i];
   }
```

```
    cout<<"\n";
    getch();
}
```

Output:-



```
HELLOWORLD
7:330(0-3;


...Program finished with exit code 0
Press ENTER to exit console.
```

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

Subject :-LP2(IS) (Transposition)

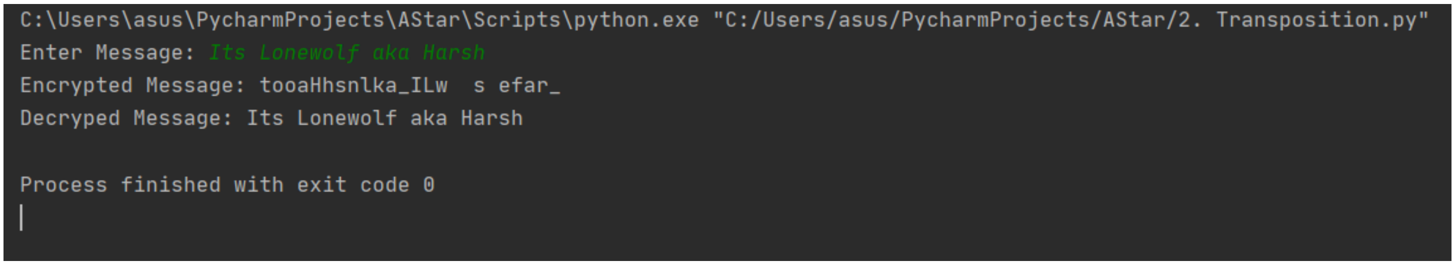
Code:-

```
import math

key = "HACK"

# Encryption
def encryptMessage(msg):
    cipher = ""

   # track key indices
    k_indx = 0

   msg_len = float(len(msg))
    msg_lst = list(msg)
    key_lst = sorted(list(key))

   # calculate column of the matrix
    col = len(key)

   # calculate maximum row of the matrix
    row = int(math.ceil(msg_len / col))

   # add the padding character '_' in empty
    # the empty cell of the matix
   fill_null = int((row * col) - msg_len)
    msg_lst.extend('_' * fill_null)

   # create Matrix and insert message and
   # padding characters row-wise
   matrix = [msg_lst[i: i + col]
             for i in range(0, len(msg_lst), col)]

   # read matrix column-wise using key
    for _ in range(col):
        curr_idx = key.index(key_lst[k_indx])
        cipher += ".join([row[curr_idx]
                          for row in matrix])
        k_indx += 1

   return cipher
```

```
# Decryption
def decryptMessage(cipher):
    msg = ""

   # track key indices
    k_indx = 0

   # track msg indices
    msg_indx = 0
    msg_len = float(len(cipher))
    msg_lst = list(cipher)

   # calculate column of the matrix
    col = len(key)

   # calculate maximum row of the matrix
    row = int(math.ceil(msg_len / col))

   # convert key into list and sort
   # alphabetically so we can access
   # each character by its alphabetical position.
    key_lst = sorted(list(key))

   # create an empty matrix to
   # store deciphered message
    dec_cipher = []
    for _ in range(row):
        dec_cipher += [[None] * col]

   # Arrange the matrix column wise according
   # to permutation order by adding into new matrix
    for _ in range(col):
        curr_idx = key.index(key_lst[k_indx])

       for j in range(row):
            dec_cipher[j][curr_idx] = msg_lst[msg_indx]
            msg_indx += 1
        k_indx += 1

   # convert decrypted msg matrix into a string
    try:
        msg = ".join(sum(dec_cipher, []))
    except TypeError:
        raise TypeError("This program cannot",
                        "handle repeating words.")

   null_count = msg.count('_')
   if null_count > 0:
        return msg[: -null_count]

   return msg

# Driver Code

msg = (input("Enter Message: "))


cipher = encryptMessage(msg)
print("Encrypted Message: {}".
               format(cipher))

print("Decryped Message: {}".
       format(decryptMessage(cipher)))
```

Output:-

```
Enter Message: Its Lonewolf aka Harsh

Encrypted Message: tooaHhsnlka_ILw  s efar_

Decryped Message: Its Lonewolf aka Harsh


Process finished with exit code 0
```



```
C:\Users\asus\PycharmProjects\AStar\Scripts\python.exe "C:/Users/asus/PycharmProjects/AStar/2. Transposition.py"
Enter Message: Its Lonewolf aka Harsh
Encrypted Message: tooaHhsnlka_ILw  s efar_
Decryped Message: Its Lonewolf aka Harsh

Process finished with exit code 0
```

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

Subject :-LP2(IS) (AES)

Code:-

```
import hashlib
from base64 import b64decode, b64encode

from Crypto import Random
from Crypto.Cipher import AES


class AESCipher(object):
    def __init__(self, key):
        self.block_size = AES.block_size
        self.key = hashlib.sha256(key.encode()).digest()

    def encrypt(self, plain_text):
        plain_text = self.__pad(plain_text)
        iv = Random.new().read(self.block_size)
        cipher = AES.new(self.key, AES.MODE_CBC, iv)
        encrypted_text = cipher.encrypt(plain_text.encode())
        return b64encode(iv + encrypted_text).decode("utf-8")

    def decrypt(self, encrypted_text):
        encrypted_text = b64decode(encrypted_text)
        iv = encrypted_text[:self.block_size]
        cipher = AES.new(self.key, AES.MODE_CBC, iv)
        plain_text = cipher.decrypt(encrypted_text[self.block_size:]).decode("utf-8")
        return self.__unpad(plain_text)

    def __pad(self, plain_text):
        number_of_bytes_to_pad = self.block_size - len(plain_text) % self.block_size
        ascii_string = chr(number_of_bytes_to_pad)
        padding_str = number_of_bytes_to_pad * ascii_string
        padded_plain_text = plain_text + padding_str
        return padded_plain_text

    @staticmethod
    def __unpad(plain_text):
        last_character = plain_text[len(plain_text) - 1:]
        return plain_text[:-ord(last_character)]


key = input("Enter Key: ")
```

```
aes = AESCipher(key)

flag = 1
while flag == 1:
    print("/*************MENU**************/")
    print("1. Encryption")
    print("2. Decryption")
    print("3. Exit ")
    choice = int(input("Enter your choice : "))

    if choice == 1:
        message = input("Enter message to encrypt: ")
        encryptedMessage = aes.encrypt(message)
        print("Encrypted Message:", encryptedMessage)

    elif choice == 2:
        message = input("Enter message to decrypt: ")
        decryptedMessage = aes.decrypt(message)
        print("Decrypted Message:", decryptedMessage)
    elif choice == 3:
        print("Exit")
        flag = 0
    else:
        print("Wrong Choice,Please Choose Another Option.")
```

Output:-

```
Enter Key: AISSMSIOIT

/*************MENU**************/

1. Encryption

2. Decryption

3. Exit

Enter your choice : 1

Enter message to encrypt: Its Lonewolf aka Harsh

Encrypted Message: mqVOvzwWn33k5g5K/iht4GhatMGOmDPlgoSQWW4YerGuKMB3/zomXaq9HJvk4rVS

/*************MENU**************/

1. Encryption
```

```
2. Decryption

3. Exit

Enter your choice : 2

Enter message to decrypt:
mqVOvzwWn33k5g5K/iht4GhatMGOmDPlgoSQWW4YerGuKMB3/zomXaq9HJvk4rVS

Decrypted Message: Its Lonewolf aka Harsh

/*************MENU**************/

1. Encryption

2. Decryption

3. Exit

Enter your choice : 5

Wrong Choice,Please Choose Another Option.

/*************MENU**************/

1. Encryption

2. Decryption

3. Exit

Enter your choice : 3

Exit


Process finished with exit code 0
```

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

Subject :-LP2(IS) (DES)

Code:-

```
# Hexadecimal to binary conversion
def hex2bin(s):
  mp = {'0' : "0000",
    '1' : "0001",
    '2' : "0010",
    '3' : "0011",
    '4' : "0100",
    '5' : "0101",
    '6' : "0110",
    '7' : "0111",
    '8' : "1000",
    '9' : "1001",
    'A' : "1010",
    'B' : "1011",
    'C' : "1100",
    'D' : "1101",
    'E' : "1110",
    'F' : "1111" }
  bin = ""
  for i in range(len(s)):
    bin = bin + mp[s[i]]
  return bin

# Binary to hexadecimal conversion
def bin2hex(s):
  mp = {"0000" : '0',
    "0001" : '1',
    "0010" : '2',
    "0011" : '3',
    "0100" : '4',
    "0101" : '5',
    "0110" : '6',
    "0111" : '7',
    "1000" : '8',
    "1001" : '9',
    "1010" : 'A',
    "1011" : 'B',
    "1100" : 'C',
    "1101" : 'D',
    "1110" : 'E',
        "1111" : 'F' }
    hex = ""
    for i in range(0,len(s),4):
        ch = ""
        ch = ch + s[i]
        ch = ch + s[i + 1]
        ch = ch + s[i + 2]
        ch = ch + s[i + 3]
        hex = hex + mp[ch]

   return hex

# Binary to decimal conversion
def bin2dec(binary):

   binary1 = binary
    decimal, i, n = 0, 0, 0
    while(binary != 0):
        dec = binary % 10
        decimal = decimal + dec * pow(2, i)
        binary = binary//10
        i += 1
    return decimal

# Decimal to binary conversion
def dec2bin(num):
    res = bin(num).replace("0b", "")
    if(len(res)%4 != 0):
        div = len(res) / 4
        div = int(div)
        counter =(4 * (div + 1)) - len(res)
        for i in range(0, counter):
            res = '0' + res
    return res

# Permute function to rearrange the bits
def permute(k, arr, n):
    permutation = ""
    for i in range(0, n):
        permutation = permutation + k[arr[i] - 1]
    return permutation

# shifting the bits towards left by nth shifts
def shift_left(k, nth_shifts):
    s = ""
    for i in range(nth_shifts):
        for j in range(1,len(k)):
            s = s + k[j]
        s = s + k[0]
        k = s
        s = ""
    return k

# calculating xow of two strings of binary number a and b
def xor(a, b):
    ans = ""
    for i in range(len(a)):
        if a[i] == b[i]:
            ans = ans + "0"
        else:
            ans = ans + "1"
    return ans

# Table of Position of 64 bits at initial level: Initial Permutation Table
initial_perm = [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]

# Expansion D-box Table
exp_d = [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 ]

# Straight Permutation Table
per = [ 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 ]

# S-box Table
sbox = [[[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] ] ]

# Final Permutation Table
final_perm = [ 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 ]

def encrypt(pt, rkb, rk):
    pt = hex2bin(pt)
  # Initial Permutation
   pt = permute(pt, initial_perm, 64)
   print("After initial permutation", bin2hex(pt))

  # Splitting
   left = pt[0:32]
   right = pt[32:64]
   for i in range(0, 16):
      # Expansion D-box: Expanding the 32 bits data into 48 bits
      right_expanded = permute(right, exp_d, 48)

     # XOR RoundKey[i] and right_expanded
      xor_x = xor(right_expanded, rkb[i])

      # S-boxex: substituting the value from s-box table by calculating row and column
      sbox_str = ""
      for j in range(0, 8):
         row = bin2dec(int(xor_x[j * 6] + xor_x[j * 6 + 5]))
         col = bin2dec(int(xor_x[j * 6 + 1] + xor_x[j * 6 + 2] + xor_x[j * 6 + 3] + xor_x[j * 6 + 4]))
         val = sbox[j][row][col]
         sbox_str = sbox_str + dec2bin(val)

     # Straight D-box: After substituting rearranging the bits
      sbox_str = permute(sbox_str, per, 32)

     # XOR left and sbox_str
      result = xor(left, sbox_str)
      left = result

     # Swapper
      if(i != 15):
         left, right = right, left
      print("Round ", i + 1, " ", bin2hex(left), " ", bin2hex(right), " ", rk[i])

  # Combination
   combine = left + right

  # Final permutation: final rearranging of bits to get cipher text
   cipher_text = permute(combine, final_perm, 64)
   return cipher_text

pt = "123456ABCD132536"
key = "AABB09182736CCDD"

# Key generation
# --hex to binary
key = hex2bin(key)
```

```
# --parity bit drop table
keyp = [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 ]

# getting 56 bit key from 64 bit using the parity bits
key = permute(key, keyp, 56)

# Number of bit shifts
shift_table = [1, 1, 2, 2,
            2, 2, 2, 2,
            1, 2, 2, 2,
            2, 2, 2, 1 ]

# Key- Compression Table : Compression of key from 56 bits to 48 bits
key_comp = [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 ]

# Splitting
left = key[0:28] # rkb for RoundKeys in binary
right = key[28:56] # rk for RoundKeys in hexadecimal

rkb = []
rk = []
for i in range(0, 16):
   # Shifting the bits by nth shifts by checking from shift table
   left = shift_left(left, shift_table[i])
   right = shift_left(right, shift_table[i])

  # Combination of left and right string
   combine_str = left + right

  # Compression of key from 56 to 48 bits
   round_key = permute(combine_str, key_comp, 48)

   rkb.append(round_key)
```

```
    rk.append(bin2hex(round_key))

print("Encryption")
cipher_text = bin2hex(encrypt(pt, rkb, rk))
print("Cipher Text : ",cipher_text)

print("Decryption")
rkb_rev = rkb[::-1]
rk_rev = rk[::-1]
text = bin2hex(encrypt(cipher_text, rkb_rev, rk_rev))
print("Plain Text : ",text)
```

Output:-

```
Encryption
After initial permutation 14A7D67818CA18AD
Round  1   18CA18AD   5A78E394   194CD072DE8C
Round  2   5A78E394   4A1210F6   4568581ABCCE
Round  3   4A1210F6   B8089591   06EDA4ACF5B5
Round  4   B8089591   236779C2   DA2D032B6EE3
Round  5   236779C2   A15A4B87   69A629FEC913
Round  6   A15A4B87   2E8F9C65   C1948E87475E
Round  7   2E8F9C65   A9FC20A3   708AD2DDB3C0
Round  8   A9FC20A3   308BEE97   34F822F0C66D
Round  9   308BEE97   10AF9D37   84BB4473DCCC
Round  10   10AF9D37   6CA6CB20   02765708B5BF
Round  11   6CA6CB20   FF3C485F   6D5560AF7CA5
Round  12   FF3C485F   22A5963B   C2C1E96A4BF3
Round  13   22A5963B   387CCDAA   99C31397C91F
Round  14   387CCDAA   BD2DD2AB   251B8BC717D0
Round  15   BD2DD2AB   CF26B472   3330C5D9A36D
Round  16   19BA9212   CF26B472   181C5D75C66D
Cipher Text :  C0B7A8D05F3A829C
```

```
Decryption
After initial permutation 19BA9212CF26B472
Round  1   CF26B472   BD2DD2AB   181C5D75C66D
Round  2   BD2DD2AB   387CCDAA   3330C5D9A36D
Round  3   387CCDAA   22A5963B   251B8BC717D0
Round  4   22A5963B   FF3C485F   99C31397C91F
Round  5   FF3C485F   6CA6CB20   C2C1E96A4BF3
Round  6   6CA6CB20   10AF9D37   6D5560AF7CA5
Round  7   10AF9D37   308BEE97   02765708B5BF
Round  8   308BEE97   A9FC20A3   84BB4473DCCC
Round  9   A9FC20A3   2E8F9C65   34F822F0C66D
Round  10   2E8F9C65   A15A4B87   708AD2DDB3C0
Round  11   A15A4B87   236779C2   C1948E87475E
Round  12   236779C2   B8089591   69A629FEC913
Round  13   B8089591   4A1210F6   DA2D032B6EE3
Round  14   4A1210F6   5A78E394   06EDA4ACF5B5
Round  15   5A78E394   18CA18AD   4568581ABCCE
Round  16   14A7D678   18CA18AD   194CD072DE8C
Plain Text :  123456ABCD132536

Process finished with exit code 0
```

Name :- Harsh Shah

CLass:- TE Computer

ERP :-67

Subject :-LP2(IS) (RSA)

Code:-

```
from Crypto.PublicKey import RSA
from Crypto.Cipher import PKCS1_OAEP
import binascii

msg = (input("Enter Message to Encrypt and Decrypt : "))
msg = bytes(msg, 'utf-8')

keyPair = RSA.generate(3072)

pubKey = keyPair.publickey()
print(f"Public key:  (n={hex(pubKey.n)}, e={hex(pubKey.e)})")
pubKeyPEM = pubKey.exportKey()
print(pubKeyPEM.decode('ascii'))

print(f"Private key: (n={hex(pubKey.n)}, d={hex(keyPair.d)})")
privKeyPEM = keyPair.exportKey()
print(privKeyPEM.decode('ascii'))

# msg = input()
encryptor = PKCS1_OAEP.new(pubKey)
encrypted = encryptor.encrypt(msg)
print("Encrypted:", binascii.hexlify(encrypted))

decryptor = PKCS1_OAEP.new(keyPair)
decrypted = decryptor.decrypt(encrypted)
print('Decrypted:', decrypted)
```

Output:-

Enter Message to Encrypt and Decrypt : Its Lonewolf aka Harsh

Public key:

```
(n=0x8c03a2f69315827592841a74e8485d7867d3e2b858df4e368efceacf6e9012c12585c34e89b41b248eb4
d3504daccf42f861325ba89ede647169e6a083c7a6a7a2c78e114edcccf1cb7be8875a500db57368d59550061
2c943bea36d214099b47c431a6a88b68f10f0366326573d1faad7f0a53e1a16efe07eb01ad0fc11e0232cd84b3
6500fb8a084e3642a99cd2280c227e431d633d2e361558eaa462e3574ca015f45584eee68e265f47aef7b1cb8e
24f4e7c90214b679ec7aed88018c1867770f74919c54f5af0bfaa948dac8fefab25e0232d1e46a2cef7e2bd386b
c59875e334ad00ac41310909b2a771b42fd7c0daafd3e110f038a5d7eff4ccce5f0e844c3981ad8a1bb2c6cfecd
65fbd3f3adf927ff124e7f2ea301bd6ad13dcabc5afc01ae3050e463bfaa3153de10e6940ab1e04fe7fd6c8a4026
```

8a2688971a281be56142c6cd7477da9465086f8ca3a818a4127815c93c65f84070157c850e6b28651c36b698
bbf75b52a89a49d93dbacf46649cf34c4de69383ec88c546334f9, e=0x10001)

-----BEGIN PUBLIC KEY-----

MIIBojANBgkqhkiG9w0BAQEFAAOCAY8AMIIBigKCAYEAjAOi9pMVgnWShBp06Ehd

eGfT4rhY3042jvzqz26QEsElhcNOibQbJI6001BNrM9C+GEyW6ie3mRxaeagg8em

p6LHjhFO3Mzxy3voh1pQDbVzaNWVUAYSyUO+o20hQJm0fEMaaoi2jxDwNmMmVz0f

qtfwpT4aFu/gfrAa0PwR4CMs2Es2UA+4oITjZCqZzSKAwifkMdYz0uNhVY6qRi41

dMoBX0VYTu5o4mX0eu97HLjiT058kCFLZ57HrtiAGMGGd3D3SRnFT1rwv6qUjayP

76sl4CMtHkaizvfivThrxZh14zStAKxBMQkJsqdxtC/XwNqv0+EQ8Dil1+/0zM5f

DoRMOYGtihuyxs/s1l+9Pzrfkn/xJOfy6jAb1q0T3KvFr8Aa4wUORjv6oxU94Q5p

QKseBP5/1sikAmiiaIlxooG+VhQsbNdHfalGUIb4yjqBikEngVyTxl+EBwFXyFDm

soZRw2tpi791tSqJpJ2T26z0ZknPNMTeaTg+yIxUYzT5AgMBAAE=

-----END PUBLIC KEY-----

Private key:
(n=0x8c03a2f69315827592841a74e8485d7867d3e2b858df4e368efceacf6e9012c12585c34e89b41b248eb4
d3504daccf42f861325ba89ede647169e6a083c7a6a7a2c78e114edcccf1cb7be8875a500db57368d59550061
2c943bea36d214099b47c431a6a88b68f10f0366326573d1faad7f0a53e1a16efe07eb01ad0fc11e0232cd84b3
6500fb8a084e3642a99cd2280c227e431d633d2e361558eaa462e3574ca015f45584eee68e265f47aef7b1cb8e
24f4e7c90214b679ec7aed88018c1867770f74919c54f5af0bfaa948dac8fefab25e0232d1e46a2cef7e2bd386b
c59875e334ad00ac41310909b2a771b42fd7c0daafd3e110f038a5d7eff4ccce5f0e844c3981ad8a1bb2c6cfecd
65fbd3f3adf927ff124e7f2ea301bd6ad13dcabc5afc01ae3050e463bfaa3153de10e6940ab1e04fe7fd6c8a4026
8a2688971a281be56142c6cd7477da9465086f8ca3a818a4127815c93c65f84070157c850e6b28651c36b698
bbf75b52a89a49d93dbacf46649cf34c4de69383ec88c546334f9,
d=0x124b055726e768089970760e712cc73d8c7f33ff76e9120c71c91c9aa66cdf6e69cb1cb5ddaaf0e2e95c39
c1a3ac60d5f4a2aa542c67395231392f5f286884df2116e67a5f6ddcbef8a183436feac6a7bee0e30ae38e2f952
92b36a9f2eec04642f7f77314d2994592c4e056698e7c5d3362670c82971d971ca64092ae645d7eeb04856b1e
b1b7230dc9b1d4190d22a564f89649669d95bf8c7f83a8be8b9a035cc32a21e2c44944ddd3894a2890d2b35b
2a166c92de2ebe6691db47c110baf3f795d3af280101f55005380ae34a5e16e19b363749e753698edded0dfe0c
e71b3db54a8a6d4ba4e2ff1c18d33595c81ec2896188993d7dd9d42f0cc9a340682d14aa3fd6b19e76712553c
9e2836eb28ad368ee223d0cd57f82aac6e10cf586adf99606476faf373d674c46fe4222ab7023fd2bedb518655
2fb48074bea0e230a2b7bf6c0d58b2d99f4671f939dbebb9f7a716a4a5ac5c3dd447156b6451752b578d675be
5c8cb85db1163f702203a1cf582c0b64bebe8992efa74cf11a43ab63)

-----BEGIN RSA PRIVATE KEY-----

MIIG5AIBAAKCAYEAjAOi9pMVgnWShBp06EhdeGfT4rhY3042jvzqz26QEsElhcNO

ibQbJI6001BNrM9C+GEyW6ie3mRxaeagg8emp6LHjhFO3Mzxy3voh1pQDbVzaNWV

UAYSyUO+o20hQJm0fEMaaoi2jxDwNmMmVz0fqtfwpT4aFu/gfrAa0PwR4CMs2Es2

UA+4oITjZCqZzSKAwifkMdYz0uNhVY6qRi41dMoBX0VYTu5o4mX0eu97HLjiT058

```
kCFLZ57HrtiAGMGGd3D3SRnFT1rwv6qUjayP76sl4CMtHkaizvfivThrxZh14zSt
AKxBMQkJsqdxtC/XwNqv0+EQ8Dil1+/0zM5fDoRMOYGtihuyxs/s1l+9Pzrfkn/x
JOfy6jAb1q0T3KvFr8Aa4wUORjv6oxU94Q5pQKseBP5/1sikAmiiaIlxooG+VhQs
bNdHfalGUIb4yjqBikEngVyTxl+EBwFXyFDmsoZRw2tpi791tSqJpJ2T26z0ZknP
NMTeaTg+yIxUYzT5AgMBAAECggGAEksFVybnaAiZcHYOcSzHPYx/M/926RIMcckc
mqZs325pyxy13arw4ulcOcGjrGDV9KKqVCxnOVIxOS9fKGiE3yEW5npfbdy++KGD
Q2/qxqe+4OMK444vlSkrNqny7sBGQvf3cxTSmUWSxOBWaY58XTNiZwyClx2XHKZA
kq5kXX7rBIVrHrG3Iw3JsdQZDSKlZPiWSWadlb+Mf4OovouaA1zDKiHixElE3dOJ
SiiQ0rNbKhZskt4uvmaR20fBELrz95XTrygBAfVQBTgK40peFuGbNjdJ51Npjt3t
Df4M5xs9tUqKbUuk4v8cGNM1lcgewolhiJk9fdnULwzJo0BoLRSqP9axnnZxJVPJ
4oNusorTaO4iPQzVf4KqxuEM9Yat+ZYGR2+vNz1nTEb+QiKrcCP9K+21GGVS+0gH
S+oOIwore/bA1YstmfRnH5OdvrufenFqSlrFw91EcVa2RRdStXjWdb5cjLhdsRY/
cCIDoc9YLAtkvr6Jku+nTPEaQ6tjAoHBALbx/mrsACpwMF4pfw0T/2j4acNtZDJb
dfIgdpXZVVNeTD8IqEWqbwq9XWds1njRRGUlyQAKBytxKjEuF5xNpXjYVf+KW1xI
f0for8ca9U+LxtOSh+jJjrvoUXouwJCFL0oIvBEJwWGAmsgouN0bVhJog/NErFZE
E/k7B6aZU5fzta54fX7mX0YLsKm5P2ggIh03LgyaYiSeMWWJqUqs0TtsTCtv0dBO
KXB3CM3S0w3GZn377LFjKnV1ci6rinDslwKBwQDD7OnMxcupvk8csUqATeX7SzX7
HrFUKbHt8YpiBx3Thnt8T4umNggviLyLlvp06qVG+7ZomnKSnbb45wGmD0ek+/GM
HK35vb8JI0RYfm7AeYGazz04Qn3So4IkSm14f/8yN6LS8ICxlpGwfX41t3EJHUPc
gusLIGD1ZoM+oZbXKpAlyOUUmTo5FJcpetKmwJkoGQk0RGFcD/mINtR7WdqDTG58
2xmXRMwz1zNVIGradVjISB7uvHpmUpIaaWLCzO8CgcEAqCAUs6ZXMKkRijeQbzBl
lM5WRCcP4cdzySRUVrn4VDlg0LzgB8Xtbm1AnX/EShvnQx1KbyLIHABPygqV4Crr
WvdVcRZxh4mIj0kj4VLBBm1qN51+EUzKQ53o4uR8S1RadSs5yl6wvS43EKN74Jby
rtAmEzaVOmIuCOlaypw12ns6CDDrA+gqvnCX1iJMRyDguQCw7Rwj/Yrz0mCEl//h
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```

```
yyE0VeDZlE2qmVnPqmjF9QghJwiQR6vBKL5WVA8xfN4pPP0RWfDlDE2VbiLLlzcO

6eGUxOVOuBNsGbykjofOXnkcBJ7zpK495nptnFeXlMDaTIIPBwGJyA==

-----END RSA PRIVATE KEY-----

Encrypted:
b'4bb51a5a7dac372b0d82ebbce2755e6660d13e5777fa6894c42fb377ab63a9ebb9a7ac75fc2c83a5ffcb11746
42317dc30deeb4818742d581654e9488919e24da3e20f7d79a8a4bfe0daee349ab8540f6ee43eea8918f089f06
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f37701c3b3aa870d3d1de56dd912c29822c57dae12d95207c'

Decrypted: b'Its Lonewolf aka Harsh'


Process finished with exit code 0
```