AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of Computer Science and Engineering

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Assignment Topic: Data Encryption Standard (DES)

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Questions:

Data Encryption Standard (DES) is a symmetric key encryption approach. It has several modes. Two such modes are ECB (Electronic Code Book) and CBC (Cipher Block Chaining).

a. Between ECB and CBC modes, which mode do you think is more secure? Justify your answer with proper explanation.

b. Write a program in C/C++/Java that takes a plaintext and a key as inputs and performs encryption and decryption with the DES mode of your answer from question a.

Solutions:

```
#include <bits/stdc++.h>
using namespace std;
#include <iostream>
#include <bitset>
#include <cstring>
int arrayresult[64];
int arrayresult2[64];


int initialpermutation[64] =
{
    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
};

int inverseinitialpermutation[64] =
{
    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
};

int pc1[56] =
{
    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
};

int pc2[48] =
{
    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
};
int numberOfShifts[16] = {1,1,2,2,2,2,2,2,1,2,2,2,2,2,2,1};
int ebitselection[48] =
{
    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
};

int permutationp[32] =
{
    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
};
int s1Box[4][16] =
{
    {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}
};

int s2Box[4][16] =
{
    {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}
};
int s3Box[4][16] =
{
    {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}
};
int s4Box[4][16] =
{
    {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}
};
int s5Box[4][16] =
{
    {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}
};
int s6Box[4][16] =
{
    {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}
};
int s7Box[4][16] =
{
    {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}
};
int s8Box[4][16] =
{
    {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}
};
int initialkey[64] =
{
    0, 0, 1, 1, 0, 1, 0, 0,
    0, 0, 1, 0, 1, 1, 0, 1,
    1, 0, 1, 1, 0, 1, 0, 1,
    1, 0, 1, 0, 1, 0, 0, 0,
    0, 0, 0, 1, 1, 1, 0, 1,
    1, 1, 0, 1, 1, 0, 1, 1,
    1, 0, 0, 1, 0, 0, 0, 0,
    0, 0, 0, 0, 0, 1, 0, 0
};
int initialvector[64] =
{
    1, 0, 1, 1, 1, 1, 0, 0,
    1, 1, 1, 0, 1, 0, 1, 1,
    0, 1, 0, 0, 0, 1, 0, 0,
    1, 1, 0, 1, 0, 0, 1, 1,
    1, 0, 1, 1, 0, 0, 0, 1,
    0, 1, 0, 0, 1, 1, 0, 1,
    0, 0, 1, 1, 1, 0, 0, 0,
    1, 1, 0, 0, 1, 0, 0, 1
};
const int ROWS = 8;
const int COLS = 8;
int inputarray[64];
void textToBinaryArray(const char* inputText, bitset<COLS> binaryArray[ROWS])
{
    int len = strlen(inputText);
    for (int i = 0; i < len; i++)
    {
        int asciiValue = static_cast<int>(inputText[i]);
        bitset<8> binaryRepresentation(asciiValue);
        for (int j = 0; j < COLS; j++)
        {
            binaryArray[i][COLS - 1 - j] = binaryRepresentation[j];
        }
    }
    for (int i = len; i < ROWS; i++)
    {
        binaryArray[i] = bitset<COLS>(string("00000001"));
    }
    int demo=0;
    for (int i = 0; i < ROWS; i++)
    {
        for (int j = 0; j < COLS; j++)
        {
            inputarray[demo]=binaryArray[i][j];
            demo++;
        }

    }
    int demo2=0;
    cout << "The input text is converted to binary:" << endl;
    for (int i = 0; i < ROWS; i++)
    {
        for (int j = 0; j < COLS; j++)
        {
            cout << inputarray[demo2] << " ";
            demo2++;
        }
        cout << endl;
    }
}
int main()
{
    cout << "Enter the input text: ";
    string inputText;
    getline(cin, inputText);
    bitset<COLS> binaryArray[ROWS];
    textToBinaryArray(inputText.c_str(), binaryArray);
    int array3[56];
    for(int i=0; i<56; i++)
    {
        int demo=pc1[i]-1;
        array3[i]=initialkey[demo];
    }
    int arrayy[48];
    int key16[16][48];
    int array4[56];
    int array5[48];
    for(int i=0; i<16; i++)
    {
        int demo=numberOfShifts[i];
        for(int j=0; j<demo; j++)
        {
            array4[27]=array3[0];
            for(int w=0; w<27; w++)
            {
                array4[w]=array3[w+1];
            }
            array4[55]=array3[28];
            for(int k=28; k<55; k++)
            {
                array4[k]=array3[k+1];
            }
            for(int x=0; x<56; x++)
            {
                array3[x]=array4[x];
            }
        }
        for(int m=0; m<56; m++)
        {
            int demo=pc2[m]-1;
            key16[i][m]=array4[demo];
        }
    }
    cout<<"All 16 keys for 16 rounds"<<endl;
    int demo2=0;
    for (int i = 0; i < 16; i++)
    {
        cout<<"Key"<<i+1<<" : ";
        for (int j = 0; j <48; j++)
        {
            cout << key16[i][j] << " ";
            demo2++;
        }
        cout << endl;
    }
    cout<<endl;

    cout<<"------------------------------------------------encryption-----------------
--------------------"<<endl;
    for(int i=0; i<64; i++)
    {
        if(inputarray[i]==initialvector[i])
        {
            inputarray[i]=0;
        }
        else
        {
            inputarray[i]=1;
        }
    }
    for(int round=0; round<16; round++)
    {
        int array2[64];
        for(int i=0; i<64; i++)
        {
            int demo=initialpermutation[i]-1;
            array2[i]=inputarray[demo];
        }
        int arrayl0[32];
        int arrayr0[32];
        for(int i=0; i<32; i++)
        {
            arrayl0[i]=array2[i];
            arrayr0[i]=array2[32+i];
        }
        int arrayl1[32];
        for(int i=0; i<32; i++)
        {
            arrayl1[i]=arrayr0[i];
        }
        int array6[48];
        for(int m=0; m<48; m++)
        {

            int demo=ebitselection[m]-1;
            array6[m]=arrayr0[demo];
        }
        for(int i=0; i<48; i++)
        {
            if(array6[i]==key16[round][i])
            {
                array6[i]=0;
            }
            else
            {
                array6[i]=1;
            }
        }
        int ar2d[8][6];
        int demo10=0;
        for(int i=0; i<8; i++)
        {
            for(int j=0; j<6; j++)
            {
                ar2d[i][j]=array6[demo10];
                demo10++;
            }
        }
        int roww=0;
        int coll=0;
        int prer0[8][4];
        for(int i=0; i<8; i++)
        {
            if((ar2d[i][0]==0 && ar2d[i][5]==0) )
            {
                roww=0;
            }
            else if((ar2d[i][0]==0 && ar2d[i][5]==1) )
            {
                roww=1;
            }
            else if((ar2d[i][0]==1 && ar2d[i][5]==0) )
            {
                roww=2;
            }
            else if((ar2d[i][0]==1 && ar2d[i][5]==1) )
            {
                roww=3;
            }
            if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)   )
            {
                coll=0;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)   )
            {
                coll=1;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)   )
            {
                coll=2;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)   )
            {
                coll=3;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)   )
            {
                coll=4;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)    )
            {
                coll=5;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
            {
                coll=6;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
            {
                coll=7;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)    )
            {
                coll=8;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)    )
            {
                coll=9;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
            {
                coll=10;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
            {
                coll=11;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)    )
            {
                coll=12;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)    )
            {
                coll=13;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
            {
                coll=14;
            }
            else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
            {
                coll=15;
            }
            int value=0;
            if(i==0)
            {
                value= s1Box[roww][coll];
            }
            else if(i==1)
```

```
{
    value= s2Box[roww][coll];
}
else if(i==2)
{
    value= s3Box[roww][coll];
}
else if(i==3)
{
    value= s4Box[roww][coll];
}
else if(i==4)
{
    value= s5Box[roww][coll];
}
else if(i==5)
{
    value= s6Box[roww][coll];
}
else if(i==6)
{
    value= s7Box[roww][coll];
}
else if(i==7)
{
    value= s8Box[roww][coll];
}
if(value==0)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==1)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=1;
}
else  if(value==2)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=0;
}
else  if(value==3)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=1;
}
else  if(value==4)
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==5)
```

```
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=0;
    prer0[i][3]=1;
}
else  if(value==6)
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=1;
    prer0[i][3]=0;
}
else  if(value==7)
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=1;
    prer0[i][3]=1;
}
else  if(value==8)
{
    prer0[i][0]=1;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==9)
{
    prer0[i][0]=1;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=1;
}
else  if(value==10)
{
    prer0[i][0]=1;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=0;
}
else  if(value==11)
{
    prer0[i][0]=1;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=1;
}
else  if(value==12)
{
    prer0[i][0]=1;
    prer0[i][1]=1;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==13)
{
    prer0[i][0]=1;
    prer0[i][1]=1;
    prer0[i][2]=0;
    prer0[i][3]=1;
}
else  if(value==14)
```

```
    {
        prer0[i][0]=1;
        prer0[i][1]=1;
        prer0[i][2]=1;
        prer0[i][3]=0;
    }
    else  if(value==15)
    {
        prer0[i][0]=1;
        prer0[i][1]=1;
        prer0[i][2]=1;
        prer0[i][3]=1;
    }
}
int finalr0[32];
int zz=0;
for (int p=0; p<8; p++)
{
    for (int q=0; q<4; q++)
    {

        finalr0[zz] = prer0[p][q];
        zz++;
    }
}
cout<<endl;

int arrayfinalr02[32];
for(int m=0; m<32; m++)
{
    int demo=permutationp[m]-1;
    arrayfinalr02[m]=finalr0[demo];
}

int arrayr1[32];

for(int i=0; i<32; i++)
{
    if(arrayl0[i]==arrayfinalr02[i])
    {
        arrayr1[i]=0;
    }
    else
    {
        arrayr1[i]=1;
    }
}
for(int i=0; i<32; i++)
{
    arrayresult[i]=arrayr1[i];
    arrayresult[32+i]=arrayl1[i];
}
cout<<"result of round :"<< round+1<<endl;

int demoo=0;
for(int i=0; i<8; i++)
{
    for(int j=0; j<8; j++)
    {
        cout<<arrayresult[demoo]<<" ";
        demoo++;
    }
    cout<<endl;
```

```
        }
        for(int i=0; i<64; i++)
        {
            array2[i]=arrayresult[i];
        }
    }
    for(int m=0; m<64; m++)
    {

        int demo=inverseinitialpermutation[m]-1;
        arrayresult2[m]=arrayresult[demo];
    }
    cout<<"Final result of encryption:"<<endl;
    int demoo=0;
    for(int i=0; i<8; i++)
    {
        for(int j=0; j<8; j++)
        {
            cout<<arrayresult2[demoo]<<" ";
            demoo++;
        }
        cout<<endl;
    }
    cout<<"------------------------------------------------Decryption-----------------
--------------------"<<endl;
    for(int i=0; i<64; i++)
    {
        inputarray[i]=arrayresult2[i];
    }
    for(int round=0; round<16; round++)
    {
        int array2[64];
        for(int i=0; i<64; i++)
        {
            int demo=initialpermutation[i]-1;
            array2[i]=inputarray[demo];
        }
        int arrayl0[32];
        int arrayr0[32];
        for(int i=0; i<32; i++)
        {
            arrayl0[i]=array2[i];
            arrayr0[i]=array2[32+i];
        }
        int arrayl1[32];
        for(int i=0; i<32; i++)
        {
            arrayl1[i]=arrayr0[i];
        }
        int array6[48];

        for(int m=0; m<48; m++)
        {

            int demo=ebitselection[m]-1;
            array6[m]=arrayr0[demo];
        }
        for(int i=0; i<48; i++)
        {
            if(array6[i]==key16[round][i])
            {
                array6[i]=0;
            }
            else
            {
                array6[i]=1;
            }
        }
        int ar2d[8][6];
        int demo10=0;
        for(int i=0; i<8; i++)
        {
            for(int j=0; j<6; j++)
            {
                ar2d[i][j]=array6[demo10];
                demo10++;
            }
        }
        int roww=0;
        int coll=0;
        int prer0[8][4];
        for(int i=0; i<8; i++)
        {
            if((ar2d[i][0]==0 && ar2d[i][5]==0) )
            {
                roww=0;
            }
            else if((ar2d[i][0]==0 && ar2d[i][5]==1) )
            {
                roww=1;
            }
            else if((ar2d[i][0]==1 && ar2d[i][5]==0) )
            {
                roww=2;
            }
            else if((ar2d[i][0]==1 && ar2d[i][5]==1) )
            {
                roww=3;
            }
            if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)   )
            {
                coll=0;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)   )
            {
                coll=1;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)   )
            {
                coll=2;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)   )
            {
                coll=3;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)   )
            {
                coll=4;
            }
            else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)   )
```

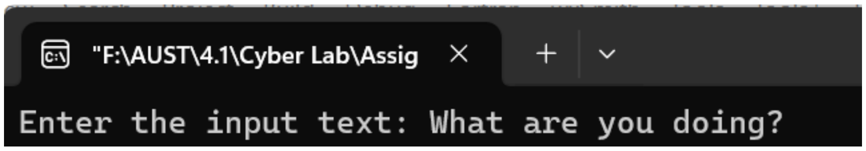
```
                {
                    coll=5;
                }
                else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
                {
                    coll=6;
                }
                else if((ar2d[i][1]==0) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
                {
                    coll=7;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)    )
                {
                    coll=8;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)    )
                {
                    coll=9;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
                {
                    coll=10;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==0) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
                {
                    coll=11;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==0)    )
                {
                    coll=12;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==0) &&
(ar2d[i][4]==1)    )
                {
                    coll=13;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==0)    )
                {
                    coll=14;
                }
                else if((ar2d[i][1]==1) && (ar2d[i][2]==1) && (ar2d[i][3]==1) &&
(ar2d[i][4]==1)    )
                {
                    coll=15;
                }
                int value=0;
                if(i==0)
                {
                    value= s1Box[roww][coll];
                }
                else if(i==1)
                {
                    value= s2Box[roww][coll];
                }
                else if(i==2)
```

```
{
    value= s3Box[roww][coll];
}
else if(i==3)
{
    value= s4Box[roww][coll];
}
else if(i==4)
{
    value= s5Box[roww][coll];
}
else if(i==5)
{
    value= s6Box[roww][coll];
}
else if(i==6)
{
    value= s7Box[roww][coll];
}
else if(i==7)
{
    value= s8Box[roww][coll];
}
if(value==0)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==1)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=0;
    prer0[i][3]=1;
}
else  if(value==2)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=0;
}
else  if(value==3)
{
    prer0[i][0]=0;
    prer0[i][1]=0;
    prer0[i][2]=1;
    prer0[i][3]=1;
}
else  if(value==4)
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=0;
    prer0[i][3]=0;
}
else  if(value==5)
{
    prer0[i][0]=0;
    prer0[i][1]=1;
    prer0[i][2]=0;
```

```
        prer0[i][3]=1;
    }
    else  if(value==6)
    {
        prer0[i][0]=0;
        prer0[i][1]=1;
        prer0[i][2]=1;
        prer0[i][3]=0;
    }
    else  if(value==7)
    {
        prer0[i][0]=0;
        prer0[i][1]=1;
        prer0[i][2]=1;
        prer0[i][3]=1;
    }
    else  if(value==8)
    {
        prer0[i][0]=1;
        prer0[i][1]=0;
        prer0[i][2]=0;
        prer0[i][3]=0;
    }
    else  if(value==9)
    {
        prer0[i][0]=1;
        prer0[i][1]=0;
        prer0[i][2]=0;
        prer0[i][3]=1;
    }
    else  if(value==10)
    {
        prer0[i][0]=1;
        prer0[i][1]=0;
        prer0[i][2]=1;
        prer0[i][3]=0;
    }
    else  if(value==11)
    {
        prer0[i][0]=1;
        prer0[i][1]=0;
        prer0[i][2]=1;
        prer0[i][3]=1;
    }
    else  if(value==12)
    {
        prer0[i][0]=1;
        prer0[i][1]=1;
        prer0[i][2]=0;
        prer0[i][3]=0;
    }
    else  if(value==13)
    {
        prer0[i][0]=1;
        prer0[i][1]=1;
        prer0[i][2]=0;
        prer0[i][3]=1;
    }
    else  if(value==14)
    {
        prer0[i][0]=1;
        prer0[i][1]=1;
        prer0[i][2]=1;
```

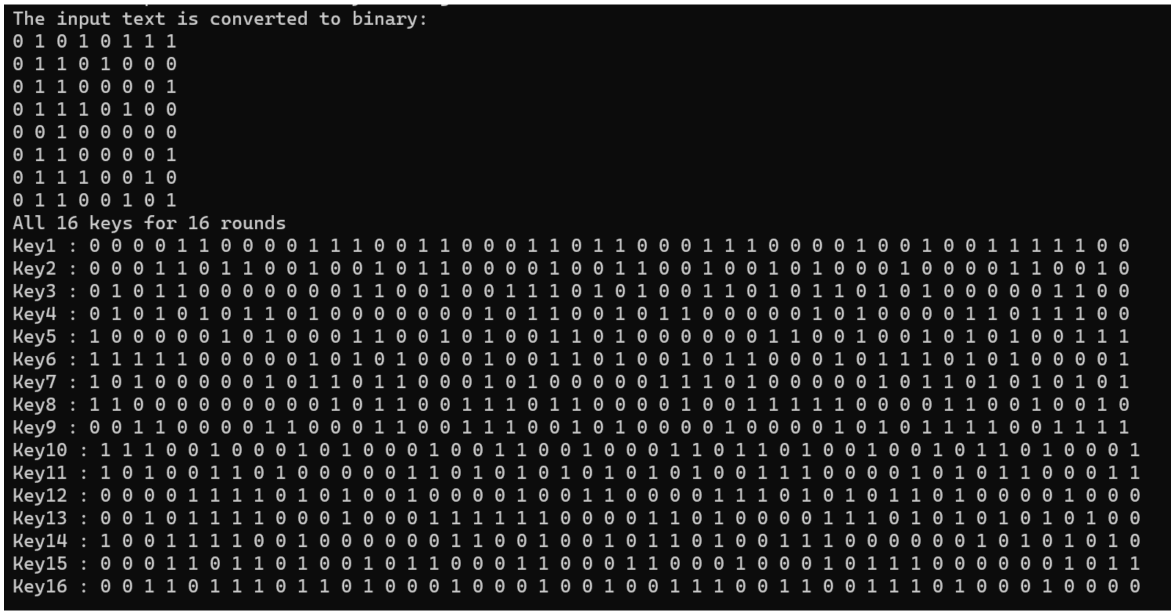
```
            prer0[i][3]=0;
        }
        else  if(value==15)
        {
            prer0[i][0]=1;
            prer0[i][1]=1;
            prer0[i][2]=1;
            prer0[i][3]=1;
        }
    }
    int finalr0[32];
    int zz=0;
    for (int p=0; p<8; p++)
    {
        for (int q=0; q<4; q++)
        {

            finalr0[zz] = prer0[p][q];
            zz++;
        }
    }
    cout<<endl;
    int arrayfinalr02[32];

    for(int m=0; m<32; m++)
    {

        int demo=permutationp[m]-1;
        arrayfinalr02[m]=finalr0[demo];
    }
    int arrayr1[32];

    for(int i=0; i<32; i++)
    {
        if(arrayl0[i]==arrayfinalr02[i])
        {
            arrayr1[i]=0;
        }
        else
        {
            arrayr1[i]=1;
        }
    }
  for(int i=0; i<32; i++)
    {
        arrayresult[i]=arrayr1[i];
        arrayresult[32+i]=arrayl1[i];
    }
    cout<<"result of round :"<< round+1<<endl;
    int demoo=0;
    for(int i=0; i<8; i++)
    {
        for(int j=0; j<8; j++)
        {
            cout<<arrayresult[demoo]<<" ";
            demoo++;
        }
        cout<<endl;
    }
    for(int i=0; i<64; i++)
    {
        array2[i]=arrayresult[i];
    }
    }
    for(int m=0; m<64; m++)
    {

        int demo=inverseinitialpermutation[m]-1;
        arrayresult2[m]=arrayresult[demo];
    }
     for(int i=0;i<64;i++)
     {
         if(arrayresult2[i]==initialvector[i])
         {
             arrayresult2[i]=0;
         }
         else
         {
             arrayresult2[i]=1;
         }
     }
    cout<<"Final result of depcryption:"<<endl;
    int demooo=0;
    for(int i=0; i<8; i++)
    {
        for(int j=0; j<8; j++)
        {
            cout<<arrayresult2[demooo]<<" ";
            demooo++;
        }
        cout<<endl;
    }

    return 0;
}
```

Input:

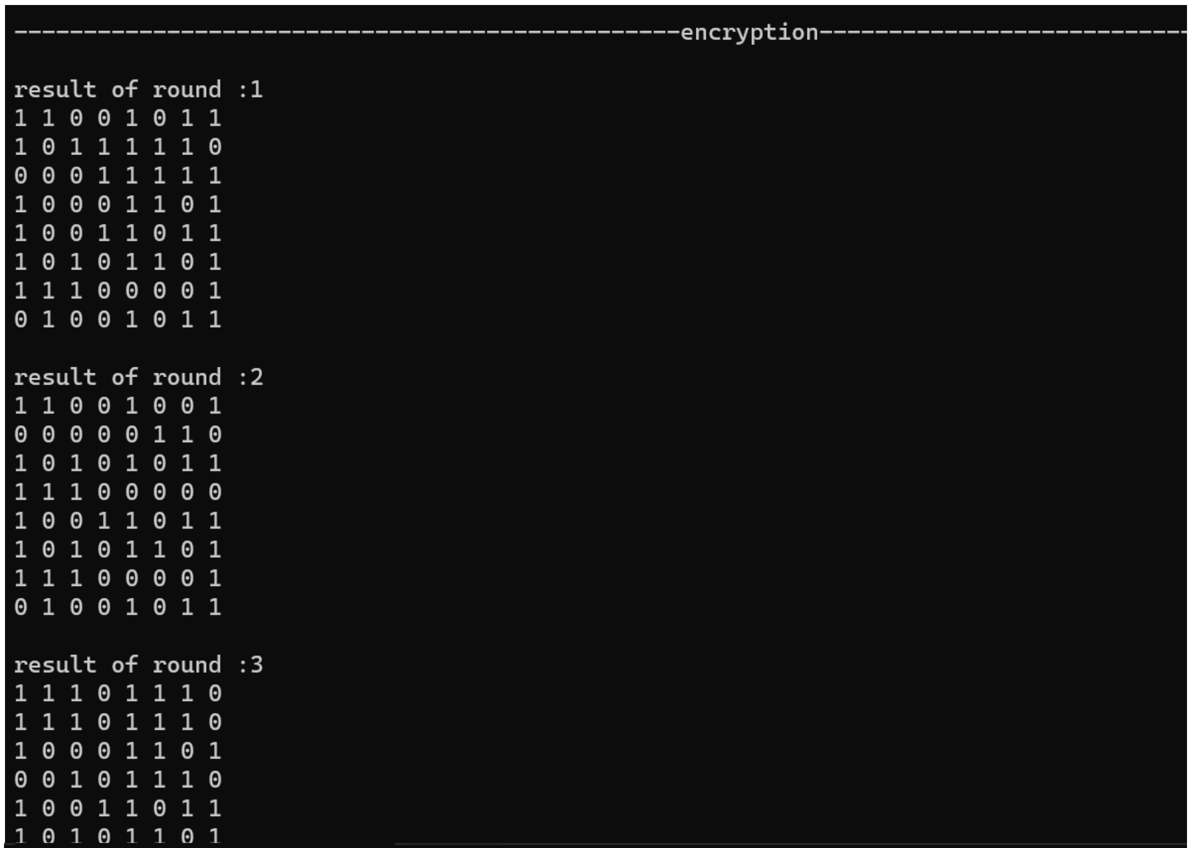


```
Enter the input text: What are you doing?
```

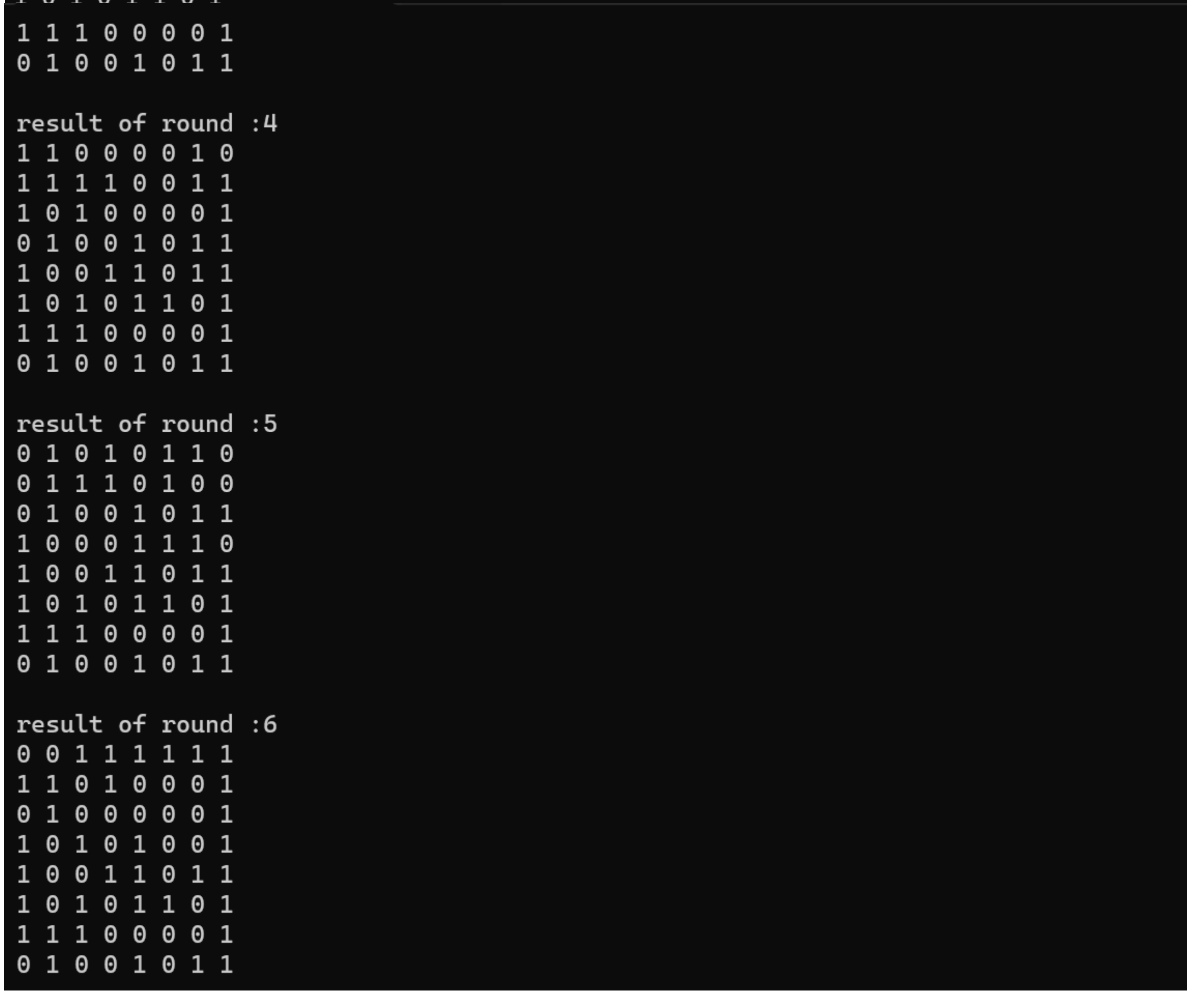
Output:



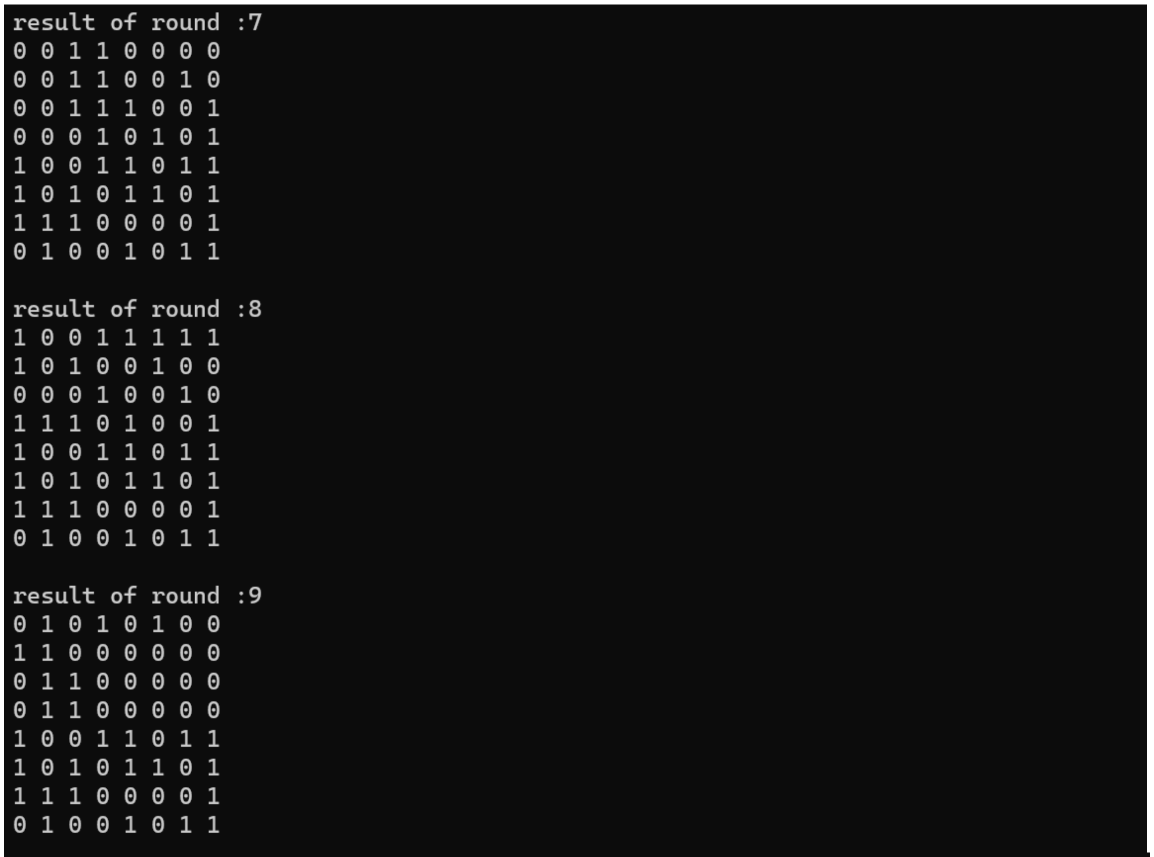
```
The input text is converted to binary:
0 1 0 1 0 1 1 1
0 1 1 0 1 0 0 0
0 1 1 0 0 0 0 1
0 1 1 1 0 1 0 0
0 0 1 0 0 0 0 0
0 1 1 0 0 0 0 1
0 1 1 1 0 0 1 0
0 1 1 0 0 1 0 1
All 16 keys for 16 rounds
Key1 : 0 0 0 0 1 1 0 0 0 0 1 1 1 0 0 1 1 0 0 0 1 1 0 1 1 0 0 0 1 1 1 0 0 0 0 1 0 0 1 0 0 1 1 1 1 1 0 0
Key2 : 0 0 0 1 1 0 1 1 0 0 1 0 0 1 0 1 1 0 0 0 0 1 0 0 1 1 0 0 1 0 0 1 0 1 0 0 0 1 0 0 0 0 1 1 0 0 1 0
Key3 : 0 1 0 1 1 0 0 0 0 0 0 0 1 1 0 0 1 0 0 1 1 1 0 1 0 1 0 0 1 1 0 1 0 1 1 0 1 0 1 0 0 0 0 0 1 1 0 0
Key4 : 0 1 0 1 0 1 0 1 1 0 1 0 0 0 0 0 0 0 1 0 1 1 0 0 1 0 1 1 0 0 0 0 0 1 0 1 0 0 0 0 1 1 0 1 1 1 0 0
Key5 : 1 0 0 0 0 0 1 0 1 0 0 0 1 1 0 0 1 0 1 0 0 1 1 0 1 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0 1 0 1 0 0 1 1 1
Key6 : 1 1 1 1 1 0 0 0 0 0 1 0 1 0 1 0 0 0 1 0 0 1 1 0 1 0 0 1 0 1 1 0 0 0 1 0 1 1 1 0 1 0 1 0 0 0 0 1
Key7 : 1 0 1 0 0 0 0 0 1 0 1 1 0 1 1 0 0 0 1 0 1 0 0 0 0 0 1 1 1 0 1 0 0 0 0 0 1 0 1 1 0 1 0 1 0 1 0 1
Key8 : 1 1 0 0 0 0 0 0 0 0 0 1 0 1 1 0 0 1 1 1 0 1 1 0 0 0 0 1 0 0 1 1 1 1 1 0 0 0 0 1 1 0 0 1 0 0 1 0
Key9 : 0 0 1 1 0 0 0 0 1 1 0 0 0 1 1 0 0 1 1 1 0 0 1 0 1 0 0 0 0 1 0 0 0 0 1 0 1 0 1 1 1 1 0 0 1 1 1 1
Key10 : 1 1 1 0 0 1 0 0 0 1 0 1 0 0 0 1 0 0 1 1 0 0 1 0 0 0 1 1 0 1 1 0 1 0 0 1 0 0 1 0 1 1 0 1 0 0 0 1
Key11 : 1 0 1 0 0 1 1 0 1 0 0 0 0 0 1 1 0 1 0 1 0 1 0 1 0 1 0 1 0 0 1 1 1 0 0 0 0 1 0 1 0 1 1 0 0 0 1 1
Key12 : 0 0 0 0 1 1 1 1 0 1 0 1 0 0 1 0 0 0 0 1 0 0 1 1 0 0 0 0 1 1 1 0 1 0 1 0 1 1 0 1 0 0 0 0 1 0 0 0
Key13 : 0 0 1 0 1 1 1 1 0 0 0 1 0 0 0 1 1 1 1 1 1 0 0 0 0 1 1 0 1 0 0 0 0 1 1 1 0 1 0 1 0 1 0 1 0 1 0 0
Key14 : 1 0 0 1 1 1 1 0 0 1 0 0 0 0 0 0 1 1 0 0 1 0 0 1 0 1 1 0 1 0 0 1 1 1 0 0 0 0 0 0 1 0 1 0 1 0 1 0
Key15 : 0 0 0 1 1 0 1 1 0 1 0 0 1 0 1 1 0 0 0 1 1 0 0 0 1 1 0 0 0 1 0 0 0 1 0 1 1 1 0 0 0 0 0 0 1 0 1 1
Key16 : 0 0 1 1 0 1 1 1 0 1 1 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 1 1 1 0 0 1 1 0 0 1 1 1 0 1 0 0 0 1 0 0 0 0
```



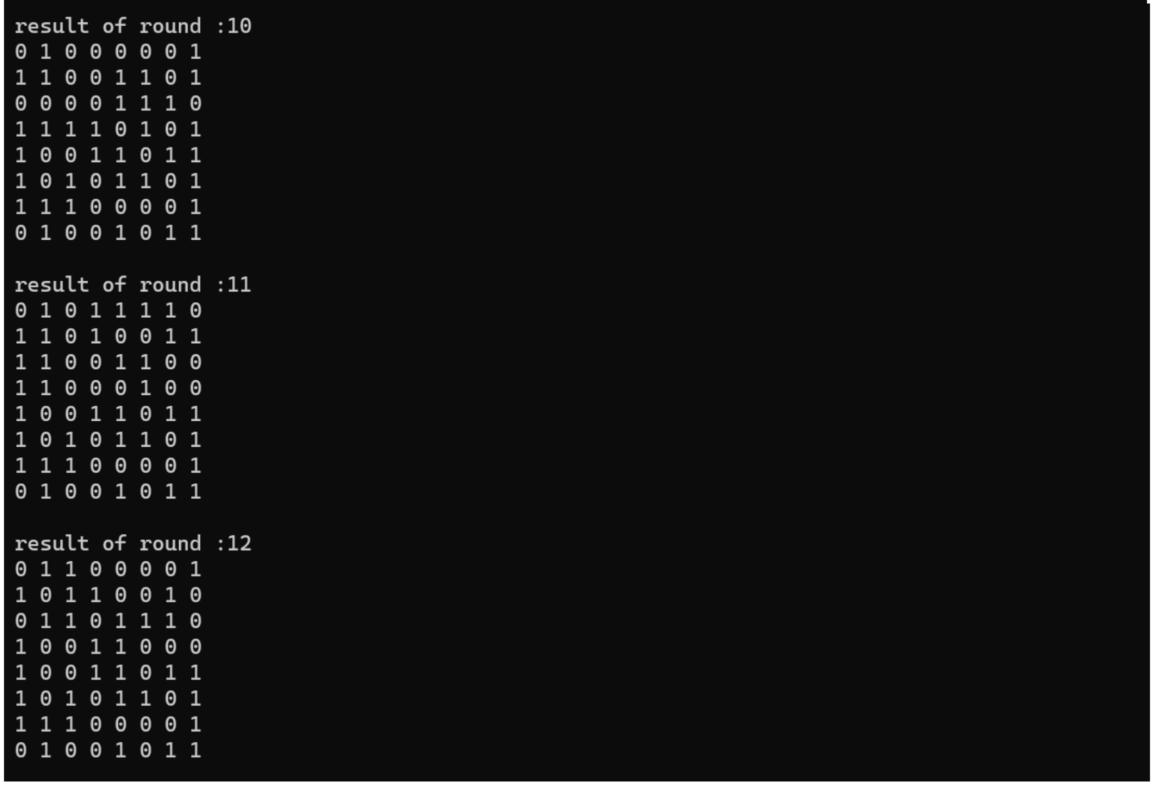
```
------------------------------------------------encryption---------------------------

result of round :1
1 1 0 0 1 0 1 1
1 0 1 1 1 1 1 0
0 0 0 1 1 1 1 1
1 0 0 0 1 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :2
1 1 0 0 1 0 0 1
0 0 0 0 0 1 1 0
1 0 1 0 1 0 1 1
1 1 1 0 0 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :3
1 1 1 0 1 1 1 0
1 1 1 0 1 1 1 0
1 0 0 0 1 1 0 1
0 0 1 0 1 1 1 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
```



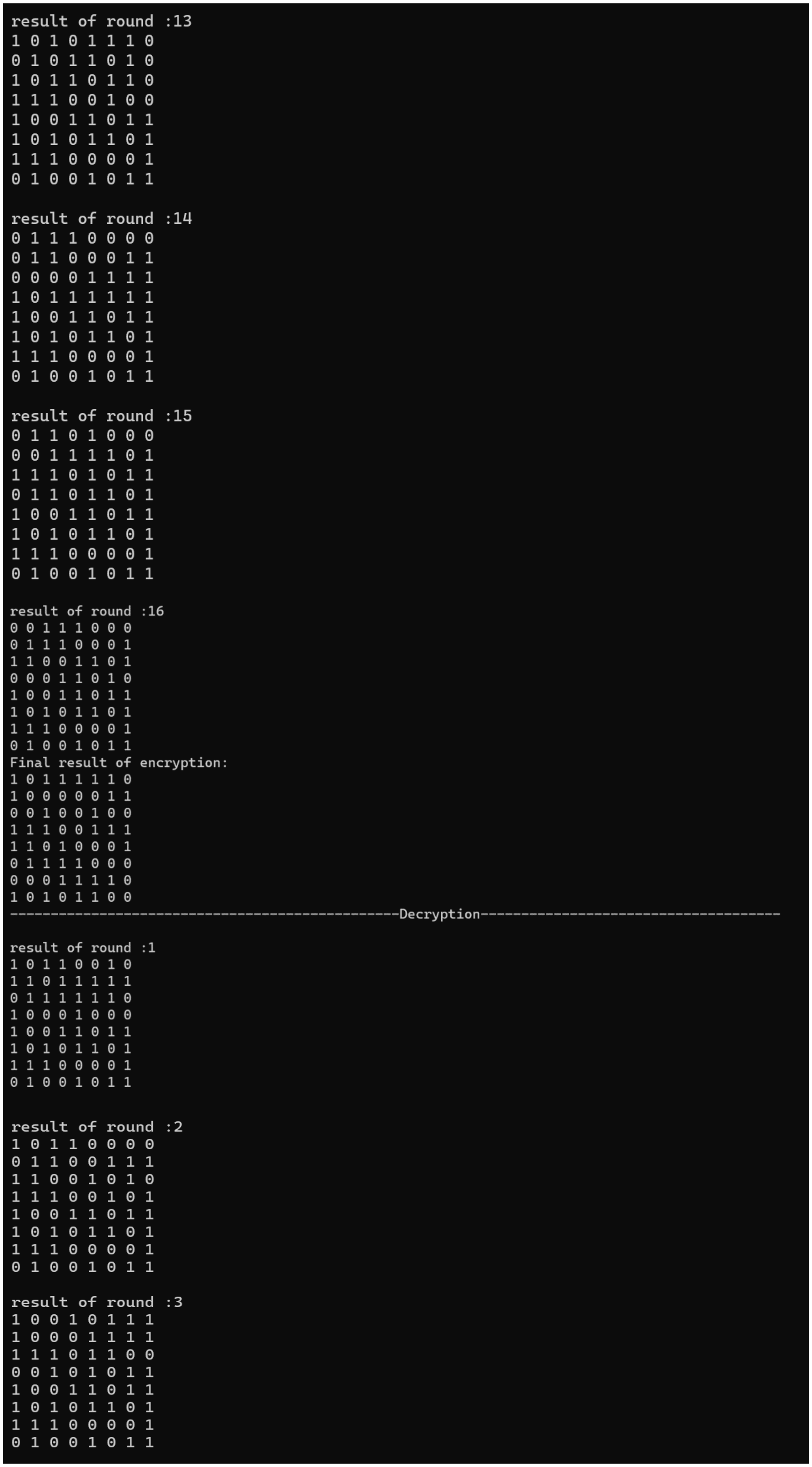
```
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :4
1 1 0 0 0 0 1 0
1 1 1 1 0 0 1 1
1 0 1 0 0 0 0 1
0 1 0 0 1 0 1 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :5
0 1 0 1 0 1 1 0
0 1 1 1 0 1 0 0
0 1 0 0 1 0 1 1
1 0 0 0 1 1 1 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :6
0 0 1 1 1 1 1 1
1 1 0 1 0 0 0 1
0 1 0 0 0 0 0 1
1 0 1 0 1 0 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```



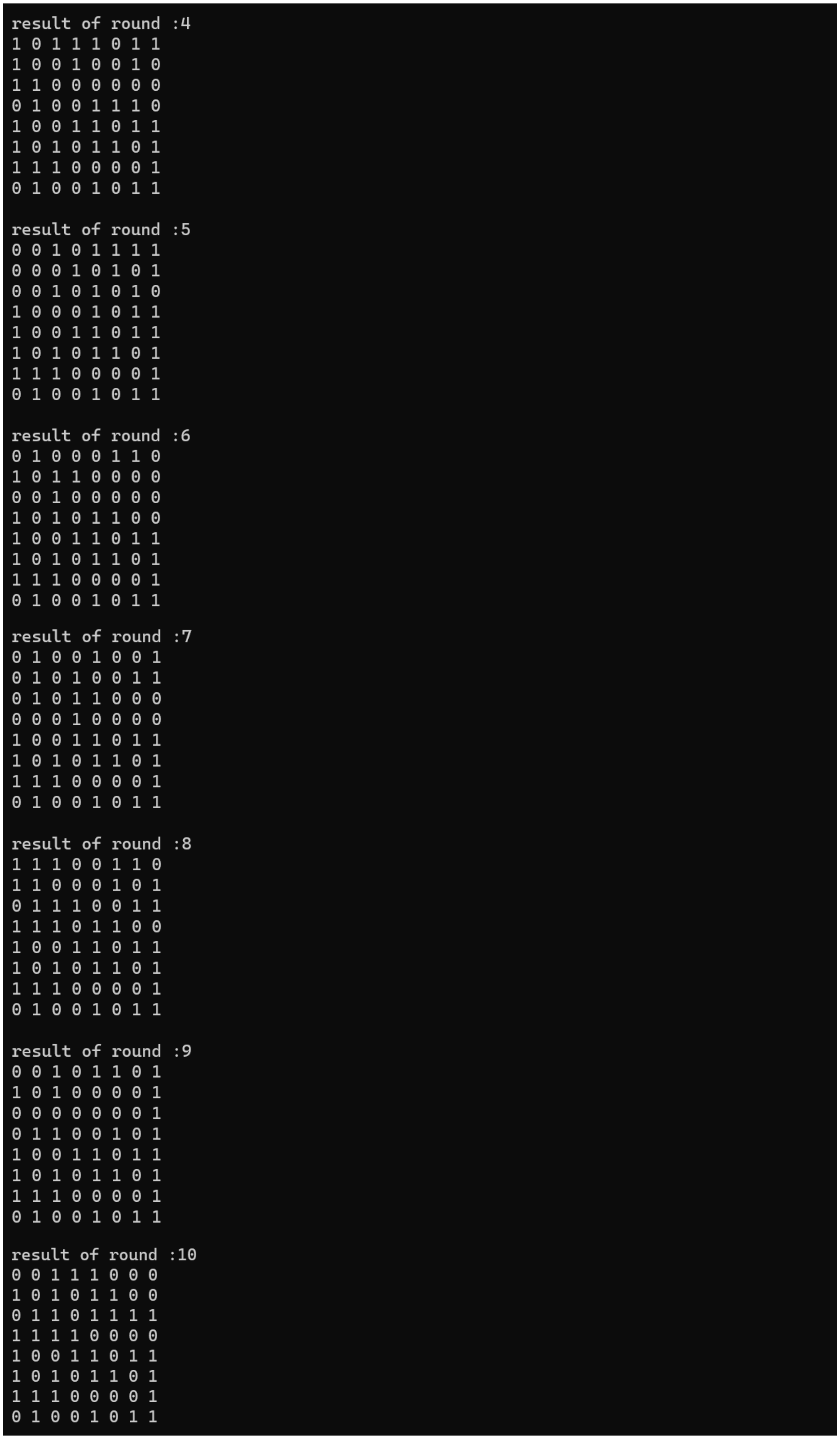
```
result of round :7
0 0 1 1 0 0 0 0
0 0 1 1 0 0 1 0
0 0 1 1 1 0 0 1
0 0 0 1 0 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :8
1 0 0 1 1 1 1 1
1 0 1 0 0 1 0 0
0 0 0 1 0 0 1 0
1 1 1 0 1 0 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :9
0 1 0 1 0 1 0 0
1 1 0 0 0 0 0 0
0 1 1 0 0 0 0 0
0 1 1 0 0 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```



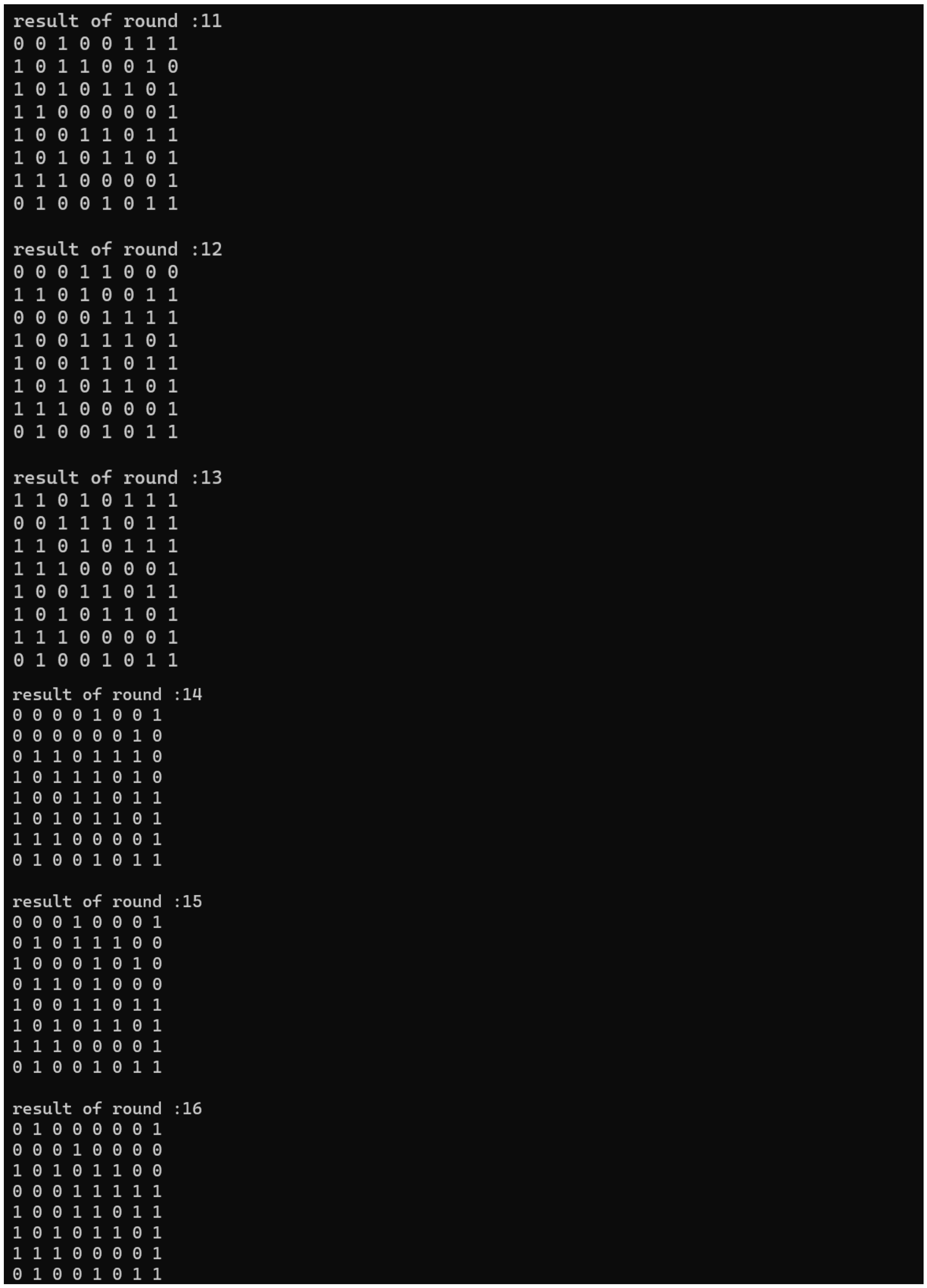
```
result of round :10
0 1 0 0 0 0 0 1
1 1 0 0 1 1 0 1
0 0 0 0 1 1 1 0
1 1 1 1 0 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :11
0 1 0 1 1 1 1 0
1 1 0 1 0 0 1 1
1 1 0 0 1 1 0 0
1 1 0 0 0 1 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :12
0 1 1 0 0 0 0 1
1 0 1 1 0 0 1 0
0 1 1 0 1 1 1 0
1 0 0 1 1 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```



```
result of round :13
1 0 1 0 1 1 1 0
0 1 0 1 1 0 1 0
1 0 1 1 0 1 1 0
1 1 1 0 0 1 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :14
0 1 1 1 0 0 0 0
0 1 1 0 0 0 1 1
0 0 0 0 1 1 1 1
1 0 1 1 1 1 1 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :15
0 1 1 0 1 0 0 0
0 0 1 1 1 1 0 1
1 1 1 0 1 0 1 1
0 1 1 0 1 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :16
0 0 1 1 1 0 0 0
0 1 1 1 0 0 0 1
1 1 0 0 1 1 0 1
0 0 0 1 1 0 1 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
Final result of encryption:
1 0 1 1 1 1 1 0
1 0 0 0 0 0 1 1
0 0 1 0 0 1 0 0
1 1 1 0 0 1 1 1
1 1 0 1 0 0 0 1
0 1 1 1 1 0 0 0
0 0 0 1 1 1 1 0
1 0 1 0 1 1 0 0
-----------------------------------------------Decryption------------------------------------

result of round :1
1 0 1 1 0 0 1 0
1 1 0 1 1 1 1 1
0 1 1 1 1 1 1 0
1 0 0 0 1 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1


result of round :2
1 0 1 1 0 0 0 0
0 1 1 0 0 1 1 1
1 1 0 0 1 0 1 0
1 1 1 0 0 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :3
1 0 0 1 0 1 1 1
1 0 0 0 1 1 1 1
1 1 1 0 1 1 0 0
0 0 1 0 1 0 1 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```

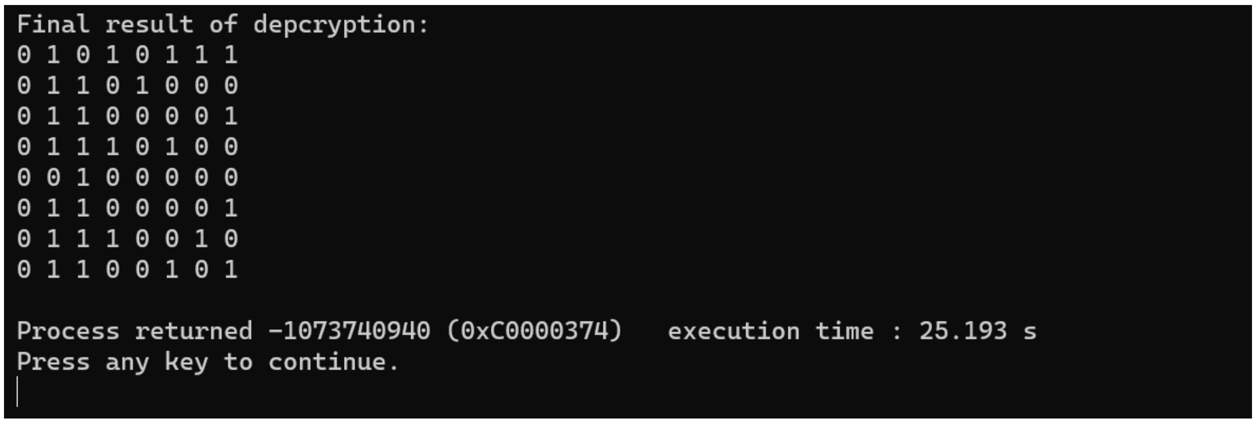


```
result of round :4
1 0 1 1 1 0 1 1
1 0 0 1 0 0 1 0
1 1 0 0 0 0 0 0
0 1 0 0 1 1 1 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :5
0 0 1 0 1 1 1 1
0 0 0 1 0 1 0 1
0 0 1 0 1 0 1 0
1 0 0 0 1 0 1 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :6
0 1 0 0 0 1 1 0
1 0 1 1 0 0 0 0
0 0 1 0 0 0 0 0
1 0 1 0 1 1 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
result of round :7
0 1 0 0 1 0 0 1
0 1 0 1 0 0 1 1
0 1 0 1 1 0 0 0
0 0 0 1 0 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :8
1 1 1 0 0 1 1 0
1 1 0 0 0 1 0 1
0 1 1 1 0 0 1 1
1 1 1 0 1 1 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :9
0 0 1 0 1 1 0 1
1 0 1 0 0 0 0 1
0 0 0 0 0 0 0 1
0 1 1 0 0 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :10
0 0 1 1 1 0 0 0
1 0 1 0 1 1 0 0
0 1 1 0 1 1 1 1
1 1 1 1 0 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```



```
result of round :11
0 0 1 0 0 1 1 1
1 0 1 1 0 0 1 0
1 0 1 0 1 1 0 1
1 1 0 0 0 0 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :12
0 0 0 1 1 0 0 0
1 1 0 1 0 0 1 1
0 0 0 0 1 1 1 1
1 0 0 1 1 1 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :13
1 1 0 1 0 1 1 1
0 0 1 1 1 0 1 1
1 1 0 1 0 1 1 1
1 1 1 0 0 0 0 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
result of round :14
0 0 0 0 1 0 0 1
0 0 0 0 0 0 1 0
0 1 1 0 1 1 1 0
1 0 1 1 1 0 1 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :15
0 0 0 1 0 0 0 1
0 1 0 1 1 1 0 0
1 0 0 0 1 0 1 0
0 1 1 0 1 0 0 0
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1

result of round :16
0 1 0 0 0 0 0 1
0 0 0 1 0 0 0 0
1 0 1 0 1 1 0 0
0 0 0 1 1 1 1 1
1 0 0 1 1 0 1 1
1 0 1 0 1 1 0 1
1 1 1 0 0 0 0 1
0 1 0 0 1 0 1 1
```

Final Result:



```
Final result of depcryption:
0 1 0 1 0 1 1 1
0 1 1 0 1 0 0 0
0 1 1 0 0 0 0 1
0 1 1 1 0 1 0 0
0 0 1 0 0 0 0 0
0 1 1 0 0 0 0 1
0 1 1 1 0 0 1 0
0 1 1 0 0 1 0 1

Process returned -1073740940 (0xC0000374)   execution time : 25.193 s
Press any key to continue.
```