Lab6

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Cryptography and Network Security Lab (BCSE309P)

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Today's task:

1. DES

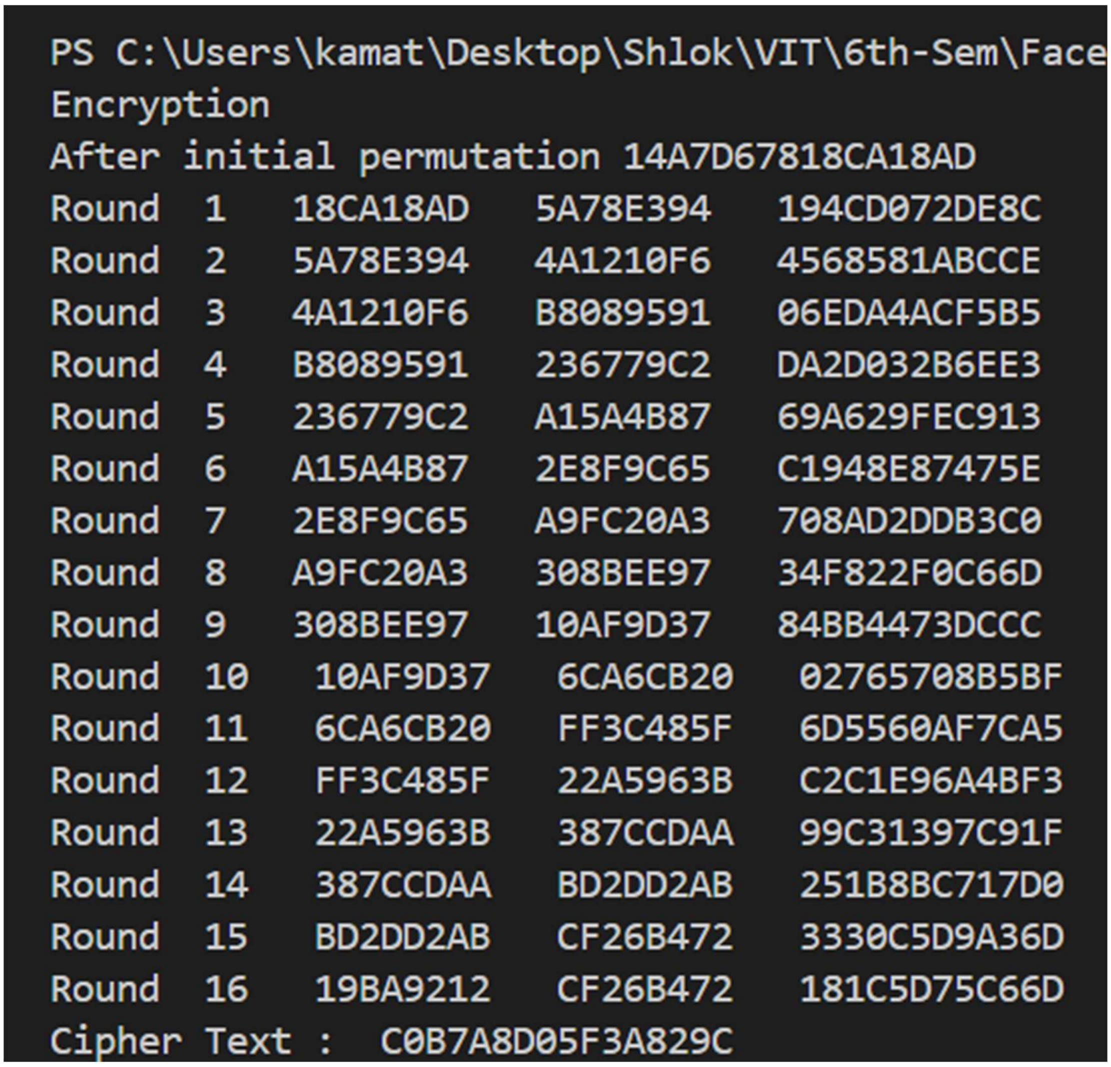
DES:

Code:

```
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



def bin2hex(s):
    mp = {"0000": '0',
        "0001": '1',
        "0010": '2',
        "0011": '3',
        "0100": '4',
        "0101": '5',
        "0110": '6',
```

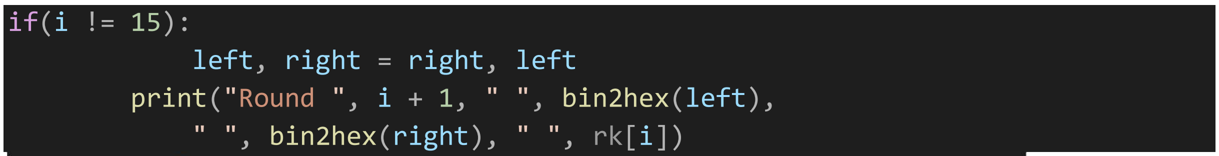
```python
        "0111": '7',
        "1000": '8',
        "1001": '9',
        "1010": 'A',
        "1011": 'B',
        "1100": 'C',
        "1101": 'D',
        "1110": 'E',
        "1111": 'F'}
    hex = ""
    for i in range(0, len(s), 4):
        ch = ""
        ch = ch + s[i]
        ch = ch + s[i + 1]
        ch = ch + s[i + 2]
        ch = ch + s[i + 3]
        hex = hex + mp[ch]

    return hex



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



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



def permute(k, arr, n):
    permutation = ""
    for i in range(0, n):
        permutation = permutation + k[arr[i] - 1]
    return permutation


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


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


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]

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]

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]

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_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)

    pt = permute(pt, initial_perm, 64)
    print("After initial permutation", bin2hex(pt))

    left = pt[0:32]
    right = pt[32:64]
    for i in range(0, 16):
        right_expanded = permute(right, exp_d, 48)

        xor_x = xor(right_expanded, rkb[i])

        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)

        sbox_str = permute(sbox_str, per, 32)

        result = xor(left, sbox_str)
        left = result

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

    combine = left + right

    cipher_text = permute(combine, final_perm, 64)
    return cipher_text


pt = "123456ABCD132536"
key = "AABB09182736CCDD"

key = hex2bin(key)

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]

key = permute(key, keyp, 56)

shift_table = [1, 1, 2, 2,
            2, 2, 2, 2,
            1, 2, 2, 2,
            2, 2, 2, 1]

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]

left = key[0:28]
right = key[28:56]

rkb = []
rk = []
for i in range(0, 16):
    left = shift_left(left, shift_table[i])
    right = shift_left(right, shift_table[i])

    combine_str = left + right

    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:

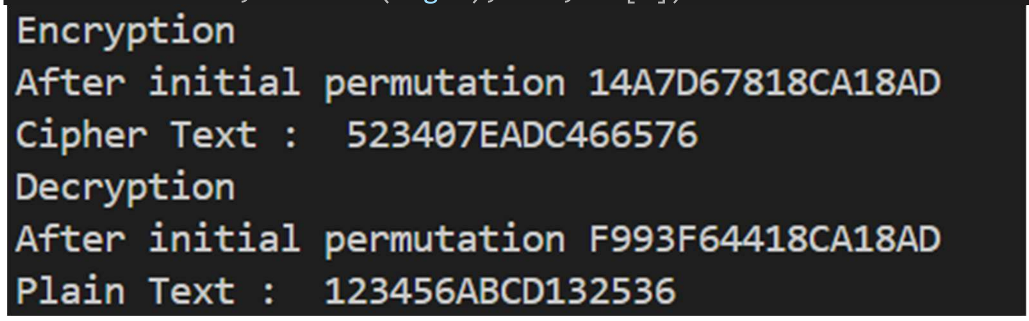


```
PS C:\Users\kamat\Desktop\Shlok\VIT\6th-Sem\Face
Encryption
After initial permutation 14A7D67818CA18AD
Round  1   18CA18AD   5A78E394   194CD072DE8C
Round  2   5A78E394   4A1210F6   4568581ABCCE
Round  3   4A1210F6   B8089591   06EDA4ACF5B5
Round  4   B8089591   236779C2   DA2D032B6EE3
Round  5   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
```

Output after commenting out:



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



```
Encryption
After initial permutation 14A7D67818CA18AD
Cipher Text :  523407EADC466576
Decryption
After initial permutation F993F64418CA18AD
Plain Text :  123456ABCD132536
```