Information Security

Practical-6: Write DES algorithm

CODE:

```
#include <stdio.h>
#include <stdlib.h>
#include <stdint.h>

#define LB32_MASK   0x00000001
#define LB64_MASK   0x0000000000000001
#define L64_MASK    0x00000000ffffffff
#define H64_MASK    0xffffffff00000000


static char IP[] = {
    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
};

static char PI[] = {
   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
};


static char 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
};



static char 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
};

static char S[8][64] = {{
   /* S1 */
   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
```

```
},{
   /* S2 */
   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
},{
   /* S3 */
   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
},{
   /* S4 */
    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
},{
   /* S5 */
    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
},{
    /* S6 */
    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
},{
    /* S7 */
     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
},{
    /* S8 */
    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
}};
```

```
static char PC1[] = {
   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
};


static char PC2[] = {
   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
};



static char iteration_shift[] = {
 /* 1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16 */
   1,  1,  2,  2,  2,  2,  2,  2,  1,  2,  2,  2,  2,  2,  2,  1
};



uint64_t des(uint64_t input, uint64_t key, char mode) {

   int i, j;



   char row, column;

   uint32_t C              = 0;
   uint32_t D              = 0;

   uint32_t L              = 0;
   uint32_t R              = 0;
```

```
uint32_t s_output         = 0;
uint32_t f_function_res   = 0;
uint32_t temp             = 0;


uint64_t sub_key[16]      = {0};
uint64_t s_input          = 0;

uint64_t permuted_choice_1  = 0;
uint64_t permuted_choice_2  = 0;


uint64_t init_perm_res    = 0;
uint64_t inv_init_perm_res  = 0;
uint64_t pre_output       = 0;


for (i = 0; i < 64; i++) {

   init_perm_res <<= 1;
   init_perm_res |= (input >> (64-IP[i])) & LB64_MASK;
```

```
}

L = (uint32_t) (init_perm_res >> 32) & L64_MASK;
R = (uint32_t) init_perm_res & L64_MASK;

for (i = 0; i < 56; i++) {

   permuted_choice_1 <<= 1;
   permuted_choice_1 |= (key >> (64-PC1[i])) & LB64_MASK;

}

C = (uint32_t) ((permuted_choice_1 >> 28) & 0x000000000fffffff);
D = (uint32_t) (permuted_choice_1 & 0x000000000fffffff);

for (i = 0; i< 16; i++) {

   for (j = 0; j < iteration_shift[i]; j++) {

      C = 0x0fffffff & (C << 1) | 0x00000001 & (C >> 27);
      D = 0x0fffffff & (D << 1) | 0x00000001 & (D >> 27);
```

```
    }

    permuted_choice_2 = 0;
    permuted_choice_2 = (((uint64_t) C) << 28) | (uint64_t) D ;

    sub_key[i] = 0;

    for (j = 0; j < 48; j++) {

       sub_key[i] <<= 1;
       sub_key[i] |= (permuted_choice_2 >> (56-PC2[j])) & LB64_MASK;

    }

}

for (i = 0; i < 16; i++) {


    s_input = 0;

    for (j = 0; j< 48; j++) {
```

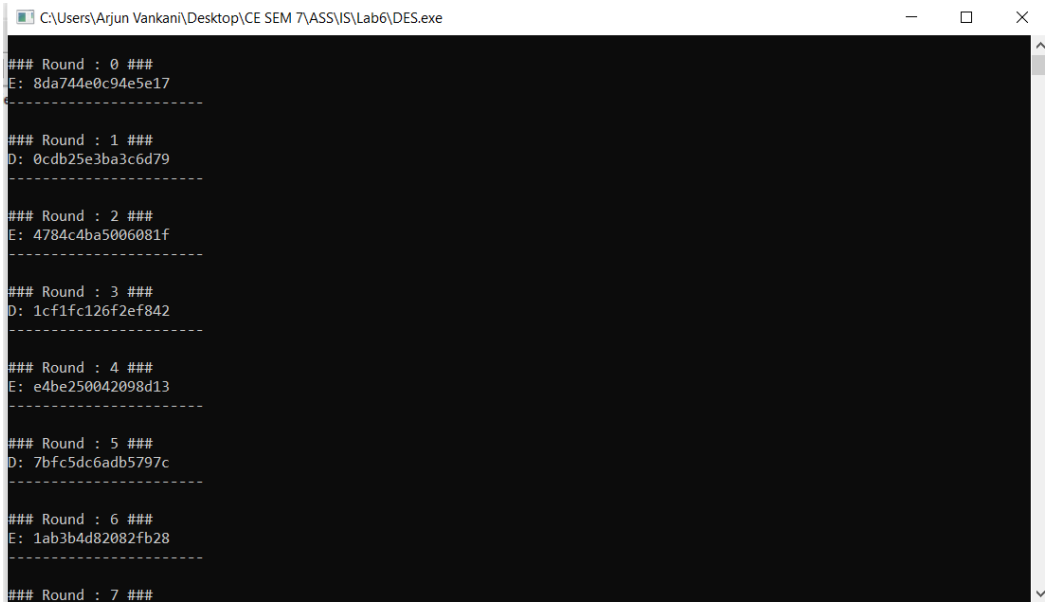
```
        s_input <<= 1;
        s_input |= (uint64_t) ((R >> (32-E[j])) & LB32_MASK);

    }


    if (mode == 'd') {
        s_input = s_input ^ sub_key[15-i];

    } else {
        s_input = s_input ^ sub_key[i];

    }

    for (j = 0; j < 8; j++) {

        row = (char) ((s_input & (0x0000840000000000 >> 6*j)) >> 42-
6*j);
        row = (row >> 4) | row & 0x01;

        column = (char) ((s_input & (0x0000780000000000 >> 6*j)) >>
43-6*j);
```

```
        s_output <<= 4;
        s_output |= (uint32_t) (S[j][16*row + column] & 0x0f);

    }

    f_function_res = 0;

    for (j = 0; j < 32; j++) {

        f_function_res <<= 1;
        f_function_res |= (s_output >> (32 - P[j])) & LB32_MASK;

    }

    temp = R;
    R = L ^ f_function_res;
    L = temp;

}

pre_output = (((uint64_t) R) << 32) | (uint64_t) L;
```

```
    for (i = 0; i < 64; i++) {

        inv_init_perm_res <<= 1;
        inv_init_perm_res |= (pre_output >> (64-PI[i])) & LB64_MASK;

    }

    return inv_init_perm_res;

}

int main(int argc, const char * argv[]) {

    int i;

    uint64_t input = 0x9474B8E8C73BCA7D;
    uint64_t key = 0x0000000000000000;
    uint64_t result = input;
```

```
  for (i = 0; i < 16; i++) {
     printf("\n### Round : %d ###\n",i);
     if (i%2 == 0) {

        result = des(result, result, 'e');
        printf ("E: %016llx\n", result);

     } else {

        result = des(result, result, 'd');
        printf ("D: %016llx\n", result);

     }
     printf("----------------------\n");
  }
  result = des(input, key, 'e');
  printf ("E: %016llx\n", result);
  result = des(result, key, 'd');
  printf ("D: %016llx\n", result);
  exit(0);
}
```

Output:


C:\Users\Arjun Vankani\Desktop\CE SEM 7\ASS\IS\Lab6\DES.exe
Round : 0
E: 8da744e0c94e5e17

Round : 1
D: 0cdb25e3ba3c6d79

Round : 2
E: 4784c4ba5006081f

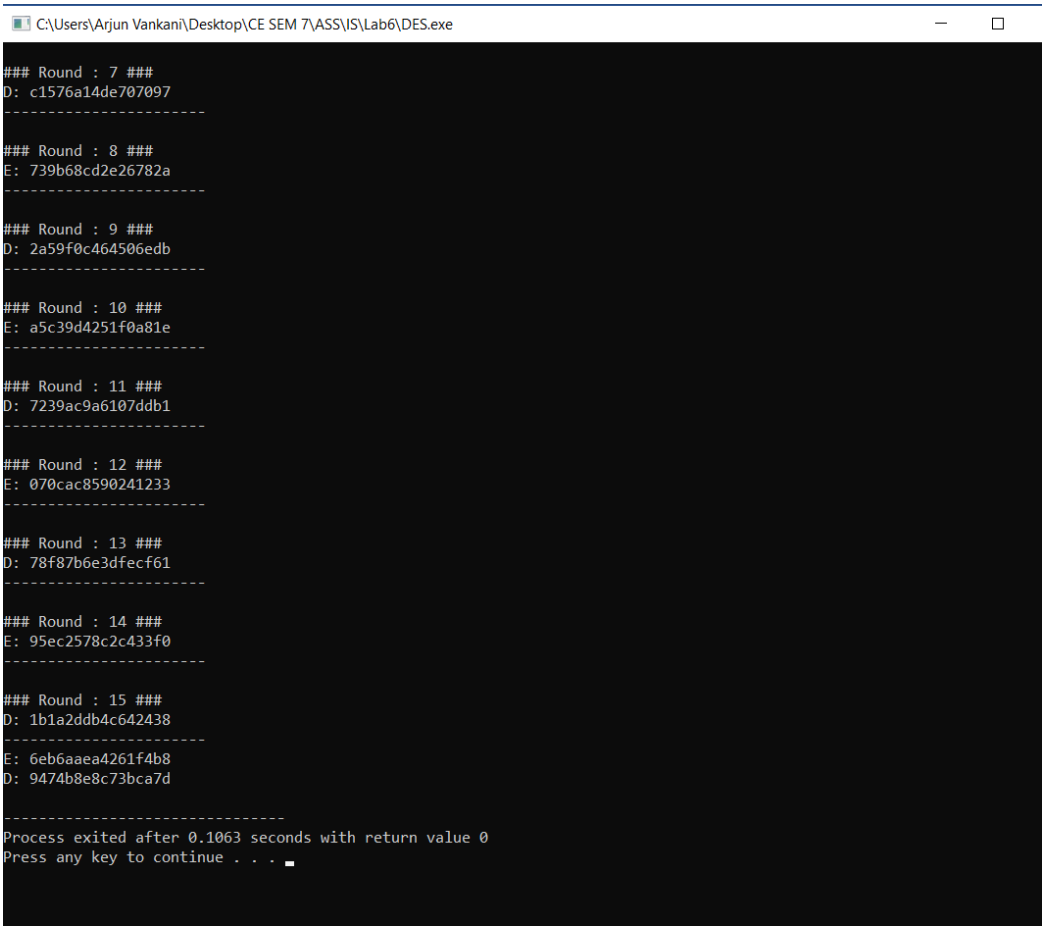
Round : 3
D: 1cf1fc126f2ef842

Round : 4
E: e4be250042098d13

Round : 5
D: 7bfc5dc6adb5797c

Round : 6
E: 1ab3b4d82082fb28

Round : 7


C:\Users\Arjun Vankani\Desktop\CE SEM 7\ASS\IS\Lab6\DES.exe
Round : 7
D: c1576a14de707097

Round : 8
E: 739b68cd2e26782a

Round : 9
D: 2a59f0c464506edb

Round : 10
E: a5c39d4251f0a81e

Round : 11
D: 7239ac9a6107ddb1

Round : 12
E: 070cac8590241233

Round : 13
D: 78f87b6e3dfecf61

Round : 14
E: 95ec2578c2c433f0

Round : 15
D: 1b1a2ddb4c642438

E: 6eb6aaea4261f4b8
D: 9474b8e8c73bca7d

Process exited after 0.1063 seconds with return value 0
Press any key to continue . . .