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Experiment 4: Write a C/C++/Java program to implement S-DES algorithm for data encryption along with key generation of S-DES.

1. Code

```
#include <stdio.h>

#include <stdlib.h>

#include <string.h>

void leftShift(char *sh)

{

   char t1 = sh[0], t2 = sh[5];

   for (int i = 0; i < 5; i++)

   {

      sh[i] = sh[(i + 1) % 5];

      sh[i + 5] = sh[(i + 1) % 5 + 5];

   }

   sh[4] = t1;

   sh[9] = t2;

}

void permutation(char *src, char *dest, int *per, int len)

{
```

```
    int i;
    for (i = 0; i < len; i++)
        dest[i] = src[per[i] - 1];
    dest[i] = 0;
}
void generateKey(char *key, char *k1, char *k2, int *p10, int *p8)
{
    char tmp[11];
    int i;
    printf("\tKey Generation Algorithm\n");
    printf("\t\tInitial 10 bit Key: %s\n", key);
    permutation(key, tmp, p10, 10);
    printf("\t\tP10 : %s\n", tmp);
    leftShift(tmp);
    printf("\t\tSH1 : %s\n", tmp);
    permutation(tmp, k1, p8, 8);
    printf("\t\tKey1 : %s\n", k1);
    leftShift(tmp);
    leftShift(tmp);
    printf("\t\tSH2 : %s\n", tmp);
    permutation(tmp, k2, p8, 8);
    printf("\t\tKey2 : %s\n", k2);
}
```

```
void generateIpPrime(int *ip, int *ipprime)
{
   for (int i = 0; i < 8; i++)
      ipprime[ip[i] - 1] = i + 1;
}
void scanInput(int *arr, int size)
{
   for (int i = 0; i < size; i++)
      scanf("%d", &arr[i]);
}
void scanSubMatrix(char ***mat)
{
   for (int i = 0; i < 4; i++)
   {
      for (int j = 0; j < 4; j++)
      {
         mat[i][j] = (char *)calloc(3, sizeof(char));
         scanf("%s", mat[i][j]);
      }
   }
}
void xorOperation(char *a, char *b, int len)
{
   for (int i = 0; i < len; i++)
```

```
    {
        if (a[i] != b[i])
            a[i] = '1';
        else
            a[i] = '0';
    }
}
void complexFunction(char *src, int *ep, char *key, char ***s0, char ***s1, int *p4)
{
    char expansion[9], substitution[5];
    int si, sj;
    permutation(src + 4, expansion, ep, 8);
    printf("\t\t\tE/P right part: %s\n", expansion);
    xorOperation(expansion, key, 8);
    printf("\t\t\tE/P xor Key: %s\n", expansion);
    si = 2 * (expansion[0] == '1') + (expansion[3] == '1');
    sj = 2 * (expansion[1] == '1') + (expansion[2] == '1');
    strncpy(substitution, s0[si][sj], 2);
    si = 2 * (expansion[4] == '1') + (expansion[7] == '1');
    sj = 2 * (expansion[5] == '1') + (expansion[6] == '1');
    strncpy(substitution + 2, s1[si][sj], 2);
    printf("\t\t\tSubstitution sequence: %s\n", substitution);
    strcpy(expansion, substitution);
    expansion[4] = 0;
```

```
    permutation(expansion, substitution, p4, 4);
    printf("\t\t\tP4: %s\n", substitution);
    xorOperation(src, substitution, 4);
    printf("\t\t\tP4 xor Left Part, Right Part: %s\n", src);
}
void swap(char *arr)
{
    char tmp;
    for (int i = 0; i < 4; i++)
    {
        tmp = arr[i];
        arr[i] = arr[i + 4];
        arr[i + 4] = tmp;
    }
}
void encryption(char *msg, char *enc, char ***s0, char ***s1, int *ep, int *ip, int *p4,
int *ipprime, char *k1, char *k2)
{
    char tmp[9];
    printf("\tEncryption Algorithm\n");
    permutation(msg, tmp, ip, 8);
    printf("\t\tInitial Permutation: %s\n", tmp);
    printf("\t\tEncryption using Key1:\n");
    complexFunction(tmp, ep, k1, s0, s1, p4);
```

```
    swap(tmp);

    printf("\t\tSwapping of Left and Right Part: %s\n", tmp);

    printf("\t\tEncryption using Key2:\n");

    complexFunction(tmp, ep, k2, s0, s1, p4);

    permutation(tmp, enc, ipprime, 8);

    printf("\t\tReverse of Initial Permutation: %s\n", enc);

}

void decryption(char *enc, char *msg, char ***s0, char ***s1, int *ep, int *ip, int *p4,
int *ipprime, char *k1, char *k2)

{

    char tmp[9];

    printf("\tDecryption Algorithm\n");

    permutation(enc, tmp, ip, 8);

    printf("\t\tInitial Permutation: %s\n", tmp);

    printf("\t\tDecryption using Key2:\n");

    complexFunction(tmp, ep, k2, s0, s1, p4);

    swap(tmp);

    printf("\t\tSwapping of Left and Right Part: %s\n", tmp);

    printf("\t\tDecryption using Key1:\n");

    complexFunction(tmp, ep, k1, s0, s1, p4);

    permutation(tmp, msg, ipprime, 8);

    printf("\t\tReverse of Initial Permutation: %s\n", msg);

}

int main()

{
```

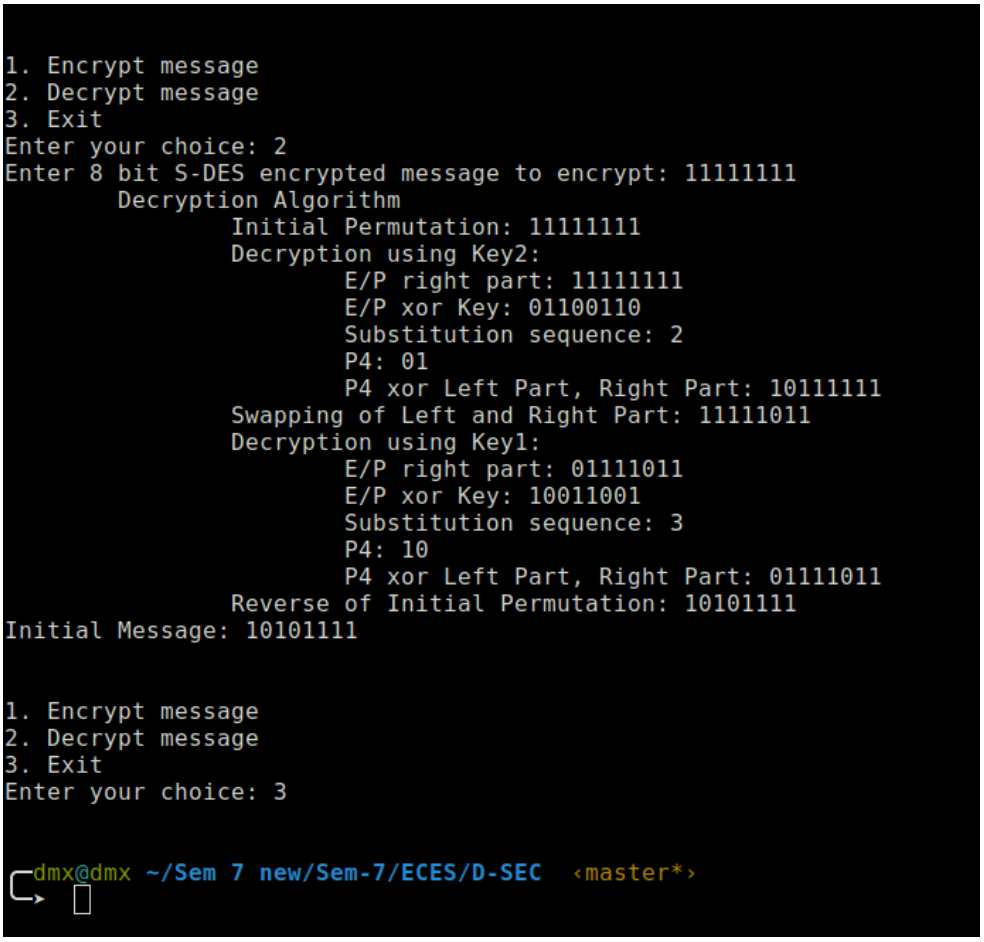
```
char message[9], encrypt[9], key[11], key1[11], key2[11];
int p10[10], p8[8], p4[4], ep[8], i, ip[8], ipprime[8], choice;
char ***s0, ***s1;
s0 = (char ***)calloc(4, sizeof(char **));
s1 = (char ***)calloc(4, sizeof(char **));
for (i = 0; i < 4; i++)
{
   s0[i] = (char **)calloc(4, sizeof(char *));
   s1[i] = (char **)calloc(4, sizeof(char *));
}
printf("Enter key value(10 bit): ");
scanf("%s", key);
printf("Enter P10 permutation sequence: ");
scanInput(p10, 10);
printf("Enter P8 permutation sequence: ");
scanInput(p8, 8);
printf("Enter P4 permutation sequence: ");
scanInput(p4, 4);
printf("Enter IP sequence: ");
scanInput(ip, 8);
printf("Enter expnsion permutation sequence: ");
scanInput(ep, 8);
printf("Enter first subtitution matrix(row vise in 2bit binary): \n");
scanSubMatrix(s0);
```

```
printf("Enter second subtitution matrix(row vise in 2bit binary): \n");
scanSubMatrix(s1);
generateIpPrime(ip, ipprime);
printf("\tIP inverse: ");
for (i = 0; i < 8; i++)
   printf("%d ", ipprime[i]);
printf("\n");
generateKey(key, key1, key2, p10, p8);
while (1)
{
   printf("1. Encrypt message\n2. Decrypt message\n3. Exit\nEnter your choice: ");
   scanf("%d", &choice);
   if (choice == 3)
      break;
   else if (choice == 1)
   {
      printf("Enter 8 bit initial message to encrypt: ");
      scanf("%s", message);
      encryption(message, encrypt, s0, s1, ep, ip, p4, ipprime, key1, key2);
      printf("S-DES encrypted message: %s\n", encrypt);
      printf("\n\n");
   }
   else if (choice == 2)
   {
```

```
            printf("Enter 8 bit S-DES encrypted message to encrypt: ");
            scanf("%s", encrypt);
            decryption(encrypt, message, s0, s1, ep, ip, p4, ipprime, key1, key2);
            printf("Initial Message: %s\n", message);
            printf("\n\n");
        }
        else
        {
            printf("\nEnter Valid Choice.\n");
        }
    }
    printf("\n\n");
    return 0;
}
```

2. Output

```
┌─dmx@dmx ~/Sem 7 new/Sem-7/ECES/D-SEC  ‹master*›
└─➤  gcc SDES.c
┌─dmx@dmx ~/Sem 7 new/Sem-7/ECES/D-SEC  ‹master*›
└─➤  ./a.out
Enter key value(10 bit): 1111100000
Enter P10 permutation sequence: 9 2 5 7 10 1 3 4 8 6
Enter P8 permutation sequence: 10 7 2 5 8 3 1 4
Enter P4 permutation sequence: 4 3 2 1
Enter IP sequence: 4 6 1 3 8 2 5 7
Enter expnsion permutation sequence: 2 4 1 3 4 2 3 1
Enter first subtitution matrix(row vise in 2bit binary):
1 0 3 2
3 2 1 0
0 2 1 3
3 1 3 2
Enter second subtitution matrix(row vise in 2bit binary):
0 1 2 3
2 0 1 3
3 0 1 0
2 1 0 3
        IP inverse: 3 6 4 1 7 2 8 5
        Key Generation Algorithm
                Initial 10 bit Key: 1111100000
                P10 : 0110011100
                SH1 : 1100011001
                Key1 : 11100010
                SH2 : 0001100111
                Key2 : 10011001
1. Encrypt message
2. Decrypt message
3. Exit
Enter your choice: 1
Enter 8 bit initial message to encrypt: 00001111
        Encryption Algorithm
                Initial Permutation: 01001011
                Encryption using Key1:
                        E/P right part: 01111011
                        E/P xor Key: 10011001
                        Substitution sequence: 3
                        P4: 10
                        P4 xor Left Part, Right Part: 11111011
                Swapping of Left and Right Part: 10111111
                Encryption using Key2:
                        E/P right part: 11111111
                        E/P xor Key: 01100110
                        Substitution sequence: 2
                        P4: 01
                        P4 xor Left Part, Right Part: 11111111
                Reverse of Initial Permutation: 11111111
S-DES encrypted message: 11111111
```


1. Encrypt message
2. Decrypt message
3. Exit
Enter your choice: 2
Enter 8 bit S-DES encrypted message to encrypt: 11111111
Decryption Algorithm
Initial Permutation: 11111111
Decryption using Key2:
E/P right part: 11111111
E/P xor Key: 01100110
Substitution sequence: 2
P4: 01
P4 xor Left Part, Right Part: 10111111
Swapping of Left and Right Part: 11111011
Decryption using Key1:
E/P right part: 01111011
E/P xor Key: 10011001
Substitution sequence: 3
P4: 10
P4 xor Left Part, Right Part: 01111011
Reverse of Initial Permutation: 10101111
Initial Message: 10101111
1. Encrypt message
2. Decrypt message
3. Exit
Enter your choice: 3
dmx@dmx ~/Sem 7 new/Sem-7/ECES/D-SEC ‹master*›