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**CLass:- TE Computer**

**ERP :-09**

**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