ASSIGNMENT-4

ADMISSION NO::U19CS082
NAME::SOURABH PATEL

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1. **Implement ERROR DETECTION technique CRC in C PROGRAMMING.**
   Create two code files sender.c and receiver.c sender.c file should accept data and key both as input in binary and encoded data(data+checksum) as output.
   receiver.c file should accept encoded data(data+checksum) and key as input and "Error Detected" OR "Error not Detected" output message.

CODE:

```
#include <bits/stdc++.h>
using namespace std;
 int main(){
  string data, key, ans="";
     cout << "Enter the dataword: ";
    cin >> data;
int len1= data.length();

    cout << "Enter the key: ";
   cin >> key;
 int len2= key.length();

    //appending zeroes to dataword
for(int i=0; i<len2-1; i++){
  data += "0";
    }
    string temp2 = "";
 for(int i=0; i<len2; i++){
    temp2 += "0";
    }
    string temp1 = data.substr(0, len2);

    //sender side     int c=len2;
while(c!= len1+len2){
  if(temp1[0] == '1'){
     for(int i=0;i<len2;i++){
```

```
            if(temp1[i]==key[i]){
              ans += "0";
            }
        else{
              ans += "1";
            }
  }
         ans.erase(ans.begin());
       temp1= ans + data[c++];
if(c!=len1+len2){
          ans="";
         }
   }
    else {
         for(int i=0;i<len2;i++){
if(temp1[i]==temp2[i]){
            ans += "0";
            }
           else{
              ans += "1";
            }
         }
         ans.erase(ans.begin());
        temp1=ans + data[c++];
if(c!=len1+len2){
         ans="";
         }
       }
 }
   string code = data.substr(0,len1) + ans;
   cout << "Codeword to be sent: " << code << endl;

   //receiver side
   temp1 = code.substr(0, len2);
  c=len2;
 ans= "";

   while(c!= len1+len2){
       if(temp1[0] == '1'){
         for(int i=0;i<len2;i++){
if(temp1[i]==key[i]){
              ans += "0";
            }
   else{
    ans += "1";
```

```
            }
  }
          ans.erase(ans.begin());
          temp1= ans + code[c++];
if(c!=len1+len2){
        ans="";
          }
  }
 else {
       for(int i=0;i<len2;i++){
if(temp1[i]==temp2[i]){
              ans += "0";
              }
    else{
                 ans += "1";
              }
     }
          ans.erase(ans.begin());
         temp1=ans + code[c++];
if(c!=len1+len2){
       ans="";
          }
       }
    }
    if(ans == temp2.substr(0,len2-1)){
      cout<< "No error";
    }
    return 0;
}
```

OUTPUT:

```
PS C:\CFG> cd "c:\CFG\" ; if ($?) { g++ tempCod
Enter the dataword: 1010011110
Enter the key: 10111
Codeword to be sent: 10100111101010
No error
PS C:\CFG>
```

2. **Implement ERROR DETECTION technique 16-bit Checksum in C PROGRAMMING. Create two code files sender.c and receiver.c**
   sender.c file should accept input string (eg. Forouzan) and encoded string(Input data+checksum) as output.
   receiver.c file should accept encoded data(data+checksum) and "Error Detected" OR "Error not Detected" output message.

SENDER FILE

```
#include <bits/stdc++.h> using
namespace std;
 string s, a="", b="", c="", d="";

string comp(string s){
    int t;
   for(int i = 0; i < 4; i++){
if(s[i]>='A'){
   t= 15 - (s[i]-55);
         s[i] = t+48 ;
        }
       else{
          t = (15 - s[i]+48);
if(t>=10){
               s[i] = t+55;
           }
       else{
          s[i] = t+48;
           }
        }    }
    return s;
}
string hex(string s, string &a, int i){
string p="";
for(int j=i; j<i+2; j++){
        int c= s[j];
int temp;
 while(c>0){
 temp = c%16;
      if(temp > 9){
           p+= temp+55;
           }
 else{
```

```
            p += temp+48;
          }
          c = c/16;
        }
  reverse(p.begin(), p.end());
        a += p;
     p="";
    }
    return a;
}
string sum(string s, string a, string b, string c, string d){
int j=0, sum=0, carry=0;
char ans[4];

    //converting every 2bits of character string to hex string
    hex(s, a, 0);
  hex(s, b, 2);
    hex(s, c, 4);
     hex(s, d, 6);
    for(int i=3; i>=0; i--){
    if(a[i]>='A'){
      sum+= a[i]-65+10;
        }
   else{
        sum+=a[i]-48;
        }
 if(b[i]>='A'){
          sum+= b[i]-65+10;
        }
 else{
            sum+=b[i]-48;
        }         if(c[i]>='A'){
sum+= c[i]-65+10;
        }         else{
sum+=c[i]-48;
        }
        if(d[i]>='A'){
          sum+= d[i]-65+10;
        }
 else{
   sum+=d[i]-48;
        }
```

```
        sum+=carry;
       carry = sum/16;
      sum %= 16;
        if(sum>=10){
          ans[i]=  55+sum;
        }
else{
         ans[i]= sum+48;
        }
sum=0;
    }

    //wrapping around the final carry
string final="";
if(carry){
for(int i=3; i>=0; i--){
          if(ans[i]>='A'){
            sum+= ans[i]-55 ;
           }
 else{
   sum+= ans[i]-48;
           }
 sum+=carry;
         carry = sum/16;
      sum %= 16;
if(sum>=10){
               final+=  sum+55;
           }
  else{
               final+= sum+48;
           }
   sum=0;
        }
       reverse(final.begin(), final.end());     }
    //returning complemented value of the final sum to obtain the checksum
  return comp(final);
} int main(){
 cout << "Input String: ";
  cin >> s;
   cout << "Checksum: "<<sum(s,a,b,c,d);
 return 0;
}
```

```
PS C:\CFG> cd "d:\1. LABS\CN\4\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\tempCodeRunne
rFile }
Input String: Forouzan
Checksum: 7038
PS D:\1. LABS\CN\4> cd "d:\1. LABS\CN\4\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\temp
CodeRunnerFile }
Input String: Computer
Checksum: 7439
PS D:\1. LABS\CN\4>
```

RECEIVER FILE

```
#include <bits/stdc++.h> using
namespace std;
 string a="", b="", c="", d="";
 string comp(string s){
   int t;
 for(int i = 0; i < 4; i++){
if(s[i]>='A'){
   t= 15 - (s[i]-55);
        s[i] = t+48 ;
       }
  else{
    t = (15 - s[i]+48);
          if(t>=10){
           s[i] = t+55;
          }
  else{
 s[i] = t+48;
          }
       }
 }
    return s;
}
string hex(string s, string &a, int i){
    string p="";
    for(int j=i; j<i+2; j++){
        int c= s[j];
  int temp;
  while(c>0){
          temp = c%16;
           if(temp > 9){
              p+= temp+55;
```

```
            }
        else{
            p += temp+48;
            }
            c = c/16;
        }
  reverse(p.begin(), p.end());
      a += p;         p="";
    }
    return a;
}
string add(string a, string b) {
   int sum=0, carry=0;
  char ans[4];
  for(int i=3; i>=0; i--){
     if(a[i]>='A'){
      sum+= a[i]-65+10;
        }
        else{
   sum+=a[i]-48;
        }
 if(b[i]>='A'){
            sum+= b[i]-65+10;
        }
 else{
 sum+=b[i]-48;
        }

        sum+=carry;
   carry = sum/16;
   sum %= 16;

        if(sum>=10){
            ans[i]=  55+sum;
        }         else{
            ans[i]= sum+48;
        }
sum=0;
    }

    //wrapping around the final carry
string final="";
```

```
    if(carry){
  for(int i=3; i>=0; i--){
if(ans[i]>='A'){
sum+= ans[i]-55 ;
            }
     else{
      sum+= ans[i]-48;
            }
sum+=carry;
      carry = sum/16;
             sum %= 16;
if(sum>=10){
                final+=  sum+55;
            }
  else{
 final+= sum+48;
            }
  sum=0;
        }
 reverse(final.begin(), final.end());
    }
else{
final = ans;
    }
return final;
}
int main(){
 string s, checksum;
 cout << "Enter the data string: ";
  cin >> s;
  cout << "Enter the Checksum: ";
   cin >> checksum;

    //converting every 2 chars of input string to hex string
  hex(s, a, 0);     hex(s, b, 2);     hex(s, c, 4);     hex(s, d, 6);

    //adding first two strings

string sum1= add(a,b);

    //adding 3rd and 4th string
string sum2= add(c,d);
```

```
   //adding the sum1 and sum2
string data= add(sum1, sum2);

   //adding final datasum to checksum
string ans = add(data,checksum);

   //taking complement of data + checksum
string complement= comp(ans);

   //if complement of data+checksum = "0000", then no error
for(int i=0;i<4;i++){
if(complement[i]!='0'){
cout << "Error detected!";
  return 0;
      }
}
cout << "No Error detected";
return 0;
}
```

OUTPUT:

```
PS C:\CFG> cd "c:\CFG\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\tempCodeRunnerFile }
Enter the data string: Forouzan
Enter the Checksum: 7038
No Error detected
PS C:\CFG>
```

Changing one data bit (a to e):

```
PS C:\CFG> cd "c:\CFG\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\tempCodeRunnerFile }
Enter the data string: Forouzen
Enter the Checksum: 7038
Error detected!
PS C:\CFG>
```

```
PS C:\CFG> cd "c:\CFG\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\tempCodeRunnerFile }
Enter the data string: Computer
Enter the Checksum: 7439
No Error detected
PS C:\CFG>
```

Changing one data bit (u to v):

```
PS C:\CFG> cd "c:\CFG\" ; if ($?) { g++ tempCodeRunnerFile.cpp -o tempCodeRunnerFile } ; if ($?) { .\tempCodeRunnerFile }
Enter the data string: Compvter
Enter the Checksum: 7439
Error detected!
PS C:\CFG>
```