FACULTY OF ENGINEERING AND TECHNOLOGY
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INFORMATION AND NETWORK SECURITY (203105311)

7th SEMESTER
7A13

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Index Table

SR No.	Practical List	Start Date	End Date	Sign	Marks
1	Implement Caesar cipher encryption-decryption				
2	Implement Monoalphabetic cipher encryption-decryption				
3	Implement Playfair cipher encryption-decryption				
4	Implement Polyalphabetic cipher encryption-decryption				
5	Implement Hill cipher encryption-decryption				
6	Implement One time pad encryption-decryption				
7	Implement One time pad encryption-decryption				
8	Implement Diffi-Hellmen Key exchange Method				
9	Implement RSA encryption-decryption algorithm				
10	Demonstrate working of Digital Signature using Cryptool				

Practical 1

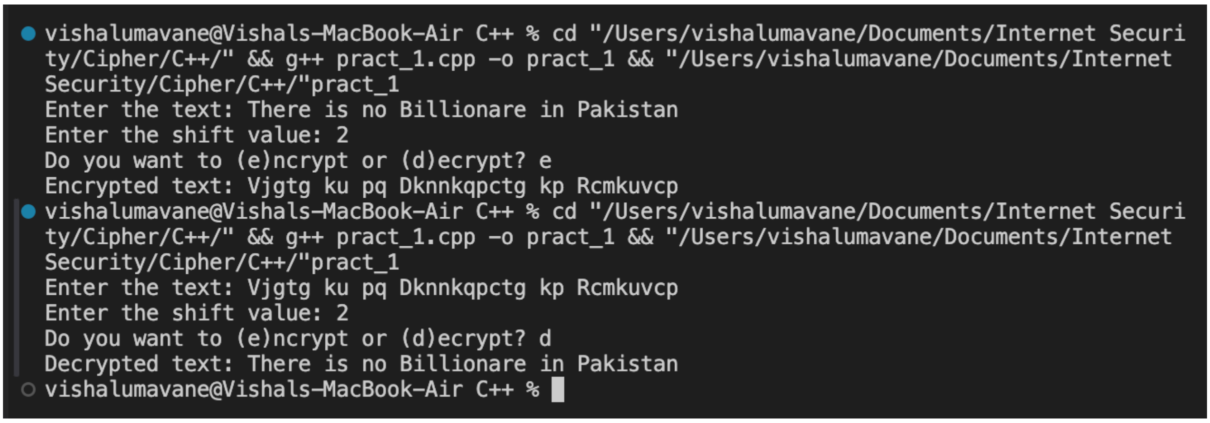
Aim : Implement Caesar cipher encryption-decryption

Implementation :

```
#include <iostream>
#include <string>

// Function to encrypt the text using Caesar Cipher
std::string encryptCaesarCipher(std::string text, int shift) {
    std::string result = "";

    // Traverse text
    for (int i = 0; i < text.length(); i++) {
        char ch = text[i];

        // Encrypt uppercase letters
        if (isupper(ch))
            result += char(int(ch + shift - 65) % 26 + 65);

        // Encrypt lowercase letters
        else if (islower(ch))
            result += char(int(ch + shift - 97) % 26 + 97);

        // Encrypt digits
        else if (isdigit(ch))
            result += char(int(ch + shift - 48) % 10 + 48);

        // Leave other characters unchanged
        else
            result += ch;
    }

    return result;
}

// Function to decrypt the text using Caesar Cipher
std::string decryptCaesarCipher(std::string text, int shift) {
    std::string result = "";

    // Traverse text
    for (int i = 0; i < text.length(); i++) {
        char ch = text[i];

        // Decrypt uppercase letters
        if (isupper(ch))
            result += char(int(ch - shift - 65 + 26) % 26 + 65);

        // Decrypt lowercase letters
        else if (islower(ch))
            result += char(int(ch - shift - 97 + 26) % 26 + 97);

        // Decrypt digits
        else if (isdigit(ch))
            result += char(int(ch - shift - 48 + 10) % 10 + 48);

        // Leave other characters unchanged
        else
            result += ch;
    }

    return result;
}

int main() {
    std::string text;
    int shift;
    char choice;

    std::cout << "Enter the text: ";
    std::getline(std::cin, text);
    std::cout << "Enter the shift value: ";
    std::cin >> shift;
    std::cout << "Do you want to (e)ncrypt or (d)ecrypt? ";
    std::cin >> choice;

    if (choice == 'e' || choice == 'E') {
        std::cout << "Encrypted text: " << encryptCaesarCipher(text, shift) << std::endl;
    } else if (choice == 'd' || choice == 'D') {
        std::cout << "Decrypted text: " << decryptCaesarCipher(text, shift) << std::endl;
    } else {
        std::cout << "Invalid choice" << std::endl;
    }

    return 0;
}
```

Outputs :

Encryption & Decryption



```
● vishalumavane@Vishals-MacBook-Air C++ % cd "/Users/vishalumavane/Documents/Internet Securi
  ty/Cipher/C++/" && g++ pract_1.cpp -o pract_1 && "/Users/vishalumavane/Documents/Internet
  Security/Cipher/C++/"pract_1
  Enter the text: There is no Billionare in Pakistan
  Enter the shift value: 2
  Do you want to (e)ncrypt or (d)ecrypt? e
  Encrypted text: Vjgtg ku pq Dknnkqpctg kp Rcmkuvcp
● vishalumavane@Vishals-MacBook-Air C++ % cd "/Users/vishalumavane/Documents/Internet Securi
  ty/Cipher/C++/" && g++ pract_1.cpp -o pract_1 && "/Users/vishalumavane/Documents/Internet
  Security/Cipher/C++/"pract_1
  Enter the text: Vjgtg ku pq Dknnkqpctg kp Rcmkuvcp
  Enter the shift value: 2
  Do you want to (e)ncrypt or (d)ecrypt? d
  Decrypted text: There is no Billionare in Pakistan
○ vishalumavane@Vishals-MacBook-Air C++ % 
```

Practical 2

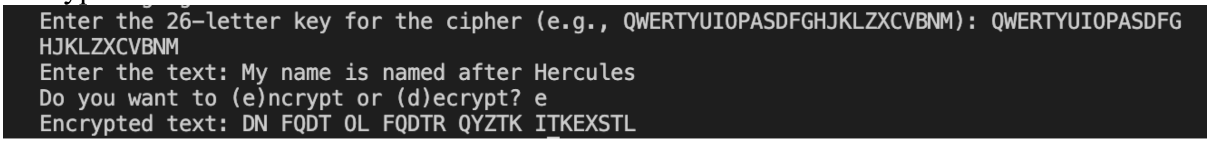
Aim: Implement Monoalphabetic cipher encryption-decryption

Implementation :

```
#include <iostream>
#include <unordered_map>
#include <string>

// Function to generate the encryption and decryption maps based on the key
void generateMaps(std::string key, std::unordered_map<char, char>& encryptMap,
std::unordered_map<char, char>& decryptMap) {
    std::string alphabet = "abcdefghijklmnopqrstuvwxyz";

    for (int i = 0; i < alphabet.length(); i++) {
        encryptMap[alphabet[i]] = key[i];
        decryptMap[key[i]] = alphabet[i];
    }
}

// Function to encrypt the text using Monoalphabetic Cipher
std::string encryptMonoalphabeticCipher(std::string text, std::unordered_map<char, char>&
encryptMap) {
    std::string result = "";

    for (char ch : text) {
        if (isalpha(ch)) {
            char lower = tolower(ch);
            result += isupper(ch) ? toupper(encryptMap[lower]) : encryptMap[lower];
        } else {
            result += ch;
        }
    }

    return result;
}

// Function to decrypt the text using Monoalphabetic Cipher
std::string decryptMonoalphabeticCipher(std::string text, std::unordered_map<char, char>&
decryptMap) {
    std::string result = "";

    for (char ch : text) {
        if (isalpha(ch)) {
            char lower = tolower(ch);
            result += isupper(ch) ? toupper(decryptMap[lower]) : decryptMap[lower];
        } else {
            result += ch;
        }
    }
    return result;
}

int main() {
    std::string text, key;
    char choice;
    std::unordered_map<char, char> encryptMap, decryptMap;

    // Prompt for key
    std::cout << "Enter the 26-letter key for the cipher (e.g., QWERTYUIOPASDFGHJKLZXCVBNM): ";
    std::cin >> key;

    // Generate maps
    generateMaps(key, encryptMap, decryptMap);

    // Clear the input buffer
    std::cin.ignore();

    // Prompt for text and choice
    std::cout << "Enter the text: ";
    std::getline(std::cin, text);
    std::cout << "Do you want to (e)ncrypt or (d)ecrypt? ";
    std::cin >> choice;

    if (choice == 'e' || choice == 'E') {
        std::cout << "Encrypted text: " << encryptMonoalphabeticCipher(text, encryptMap) << std::endl;
    } else if (choice == 'd' || choice == 'D') {
        std::cout << "Decrypted text: " << decryptMonoalphabeticCipher(text, decryptMap) << std::endl;
    } else {
        std::cout << "Invalid choice" << std::endl;
    }

    return 0;
}
```

Outputs :

Encryption



```
Enter the 26-letter key for the cipher (e.g., QWERTYUIOPASDFGHJKLZXCVBNM): QWERTYUIOPASDFG
HJKLZXCVBNM
Enter the text: My name is named after Hercules
Do you want to (e)ncrypt or (d)ecrypt? e
Encrypted text: DN FQDT OL FQDTR QYZTK ITKEXSTL
```

Practical 3

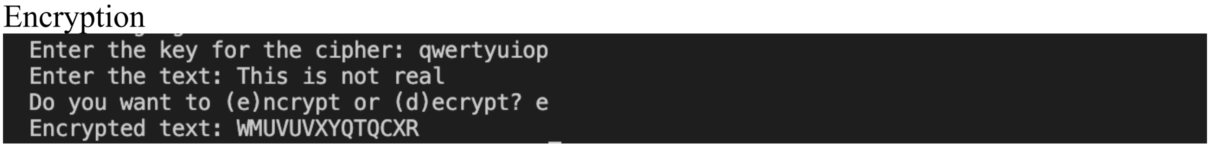
Aim : Implement Playfair cipher encryption-decryption

Implementation :

```
#include <iostream>
#include <vector>
#include <algorithm>
#include <cctype>
#include <string>
#include <unordered_set>

// Function to generate the Playfair matrix based on the key
void generateMatrix(std::string key, char matrix[5][5]) {
    std::string keyString = "";
    std::unordered_set<char> usedChars;

    // Add key characters to keyString, removing duplicates and ignoring 'J'
    for (char ch : key) {
        ch = toupper(ch);
        if (ch == 'J') ch = 'I';
        if (usedChars.find(ch) == usedChars.end() && isalpha(ch)) {
            keyString += ch;
            usedChars.insert(ch);
        }
    }

    // Add remaining letters to keyString
    for (char ch = 'A'; ch <= 'Z'; ch++) {
        if (ch == 'J') continue;
        if (usedChars.find(ch) == usedChars.end()) {
            keyString += ch;
            usedChars.insert(ch);
        }
    }

    // Fill the matrix
    int k = 0;
    for (int i = 0; i < 5; i++) {
        for (int j = 0; j < 5; j++) {
            matrix[i][j] = keyString[k++];
        }
    }
}

// Function to find the position of a character in the matrix
void findPosition(char matrix[5][5], char ch, int &row, int &col) {
    if (ch == 'J') ch = 'I'; // Treat 'J' as 'I'
    for (int i = 0; i < 5; i++) {
        for (int j = 0; j < 5; j++) {
            if (matrix[i][j] == ch) {
                row = i;
                col = j;
                return;
            }
        }
    }
}

// Function to process text by removing non-alphabetic characters and handling duplicate letters in
digraphs
std::string processText(std::string text) {
    std::string result = "";
    for (char ch : text) {
        if (isalpha(ch)) {
            ch = toupper(ch);
            result += (ch == 'J') ? 'I' : ch;
        }
    }

    // Handle duplicate letters in digraphs
    for (size_t i = 0; i < result.length(); i += 2) {
        if (i + 1 < result.length() && result[i] == result[i + 1]) {
            result.insert(i + 1, "X");
        }
    }

    // If the processed text has an odd number of characters, add 'X' at the end
    if (result.length() % 2 != 0) {
        result += 'X';
    }

    return result;
}

// Function to encrypt the text using Playfair Cipher
std::string encryptPlayfairCipher(std::string text, char matrix[5][5]) {
    std::string result = "";
    text = processText(text);

    for (size_t i = 0; i < text.length(); i += 2) {
        char first = text[i];
        char second = text[i + 1];
        int row1, col1, row2, col2;

        findPosition(matrix, first, row1, col1);
        findPosition(matrix, second, row2, col2);

        if (row1 == row2) {
            result += matrix[row1][(col1 + 1) % 5];
            result += matrix[row2][(col2 + 1) % 5];
        } else if (col1 == col2) {
            result += matrix[(row1 + 1) % 5][col1];
            result += matrix[(row2 + 1) % 5][col2];
        } else {
            result += matrix[row1][col2];
            result += matrix[row2][col1];
        }
    }

    return result;
}

// Function to decrypt the text using Playfair Cipher
std::string decryptPlayfairCipher(std::string text, char matrix[5][5]) {
    std::string result = "";
    text = processText(text);

    for (size_t i = 0; i < text.length(); i += 2) {
        char first = text[i];
        char second = text[i + 1];
        int row1, col1, row2, col2;

        findPosition(matrix, first, row1, col1);
        findPosition(matrix, second, row2, col2);

        if (row1 == row2) {
            result += matrix[row1][(col1 + 4) % 5];
            result += matrix[row2][(col2 + 4) % 5];
        } else if (col1 == col2) {
            result += matrix[(row1 + 4) % 5][col1];
            result += matrix[(row2 + 4) % 5][col2];
        } else {
            result += matrix[row1][col2];
            result += matrix[row2][col1];
        }
    }

    return result;
}

int main() {
    std::string text, key;
    char choice;
    char matrix[5][5];

    // Prompt for key
    std::cout << "Enter the key for the cipher: ";
    std::getline(std::cin, key);
    // Generate matrix
    generateMatrix(key, matrix);

    // Prompt for text and choice
    std::cout << "Enter the text: ";
    std::getline(std::cin, text);
    std::cout << "Do you want to (e)ncrypt or (d)ecrypt? ";
    std::cin >> choice;

    if (choice == 'e' || choice == 'E') {
        std::cout << "Encrypted text: " << encryptPlayfairCipher(text, matrix) << std::endl;
    } else if (choice == 'd' || choice == 'D') {
        std::cout << "Decrypted text: " << decryptPlayfairCipher(text, matrix) << std::endl;
    } else {
        std::cout << "Invalid choice" << std::endl;
    }

    return 0;
}
```

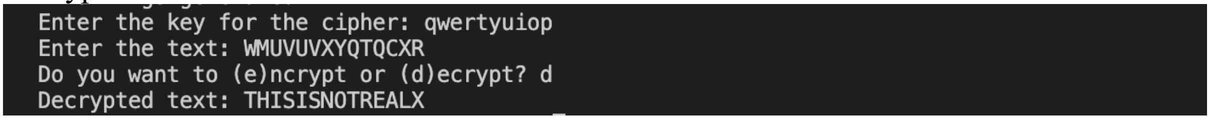
Outputs :

Encryption



```
Enter the key for the cipher: qwertyuiop
Enter the text: This is not real
Do you want to (e)ncrypt or (d)ecrypt? e
Encrypted text: WMUVUVXYQTQCXR
```

Decryption



```
Enter the key for the cipher: qwertyuiop
Enter the text: WMUVUVXYQTQCXR
Do you want to (e)ncrypt or (d)ecrypt? d
Decrypted text: THISISNOTREALX
```

Practical 4

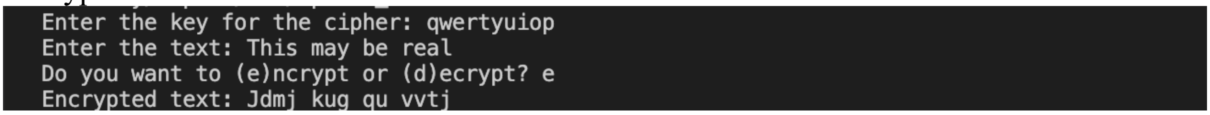
Aim : Implement Polyalphabetic cipher encryption-decryption

Implementation :

```
#include <iostream>
#include <string>
// Function to extend the key to match the length of the text
std::string extendKey(const std::string &text, const std::string &key) {
    std::string extendedKey = key;
    int textLength = text.length();
    int keyLength = key.length();
    for (int i = 0; i < textLength - keyLength; i++) {
        extendedKey += key[i % keyLength];
    }
    return extendedKey;
}
// Function to encrypt the text using Vigenère Cipher
std::string encryptVigenereCipher(const std::string &text, const std::string &key) {
    std::string encryptedText = "";
    std::string extendedKey = extendKey(text, key);

    for (size_t i = 0; i < text.length(); i++) {
        char ch = text[i];
        if (isalpha(ch)) {
            char base = isupper(ch) ? 'A' : 'a';
            char keyCh = toupper(extendedKey[i]) - 'A';
            encryptedText += (ch - base + keyCh) % 26 + base;
        } else {
            encryptedText += ch;
        }
    }

    return encryptedText;
}
// Function to decrypt the text using Vigenère Cipher
std::string decryptVigenereCipher(const std::string &text, const std::string &key) {
    std::string decryptedText = "";
    std::string extendedKey = extendKey(text, key);

    for (size_t i = 0; i < text.length(); i++) {
        char ch = text[i];
        if (isalpha(ch)) {
            char base = isupper(ch) ? 'A' : 'a';
            char keyCh = toupper(extendedKey[i]) - 'A';
            decryptedText += (ch - base - keyCh + 26) % 26 + base;
        } else {
            decryptedText += ch;
        }
    }
    return decryptedText;
}
int main() {
    std::string text, key;
    char choice;
    // Prompt for key
    std::cout << "Enter the key for the cipher: ";
    std::getline(std::cin, key);
    // Prompt for text and choice
    std::cout << "Enter the text: ";
    std::getline(std::cin, text);
    std::cout << "Do you want to (e)ncrypt or (d)ecrypt? ";
    std::cin >> choice;
    if (choice == 'e' || choice == 'E') {
        std::cout << "Encrypted text: " << encryptVigenereCipher(text, key) << std::endl;
    } else if (choice == 'd' || choice == 'D') {
        std::cout << "Decrypted text: " << decryptVigenereCipher(text, key) << std::endl;
    } else {
        std::cout << "Invalid choice" << std::endl;
    }

    return 0;
}
```

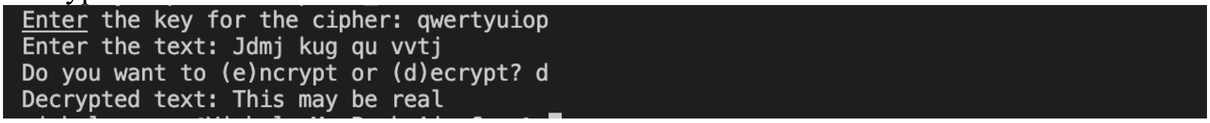
Outputs :

Encryption



```
Enter the key for the cipher: qwertyuiop
Enter the text: This may be real
Do you want to (e)ncrypt or (d)ecrypt? e
Encrypted text: Jdmj kug qu vvtj
```

Decryption



```
Enter the key for the cipher: qwertyuiop
Enter the text: Jdmj kug qu vvtj
Do you want to (e)ncrypt or (d)ecrypt? d
Decrypted text: This may be real
```

Practical 5

Aim : Implement hill cipher encryption and decryption

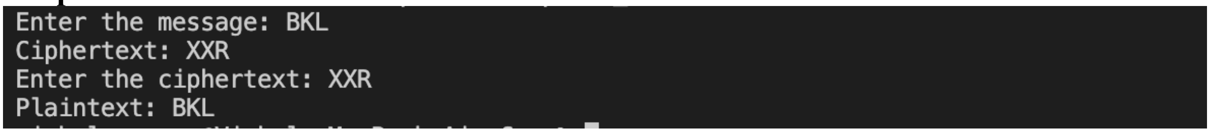
Implementation :

```
#include <iostream>
#include <vector>
#include <cmath>
using namespace std;

// Function to generate the key matrix from the key string
void getKeyMatrix(string key, int keyMatrix[][3]) {
    int k = 0;
    for (int i = 0; i < 3; i++) {
        for (int j = 0; j < 3; j++) {
            keyMatrix[i][j] = (key[k]) % 65;
            k++;
        }
    }
}

// Function to get the cofactor matrix
void getCofactor(int matrix[3][3], int temp[3][3], int p, int q, int n) {
    int i = 0, j = 0;
    for (int row = 0; row < n; row++) {
        for (int col = 0; col < n; col++) {
            if (row != p && col != q) {
                temp[i][j++] = matrix[row][col];
                if (j == n - 1) {
                    j = 0;
                    i++;
                }
            }
        }
    }
}

// Function to calculate the determinant of the matrix
int determinant(int matrix[3][3], int n) {
    int det = 0;
    if (n == 1) return matrix[0][0];

    int temp[3][3];
    int sign = 1;
    for (int i = 0; i < n; i++) {
        getCofactor(matrix, temp, 0, i, n);
        det += sign * matrix[0][i] * determinant(temp, n - 1);
        sign = -sign;
    }
    return det;
}

// Function to find adjoint of a matrix
void adjoint(int matrix[3][3], int adj[3][3]) {
    if (3 == 1) {
        adj[0][0] = 1;
        return;
    }

    int sign = 1, temp[3][3];
    for (int i = 0; i < 3; i++) {
        for (int j = 0; j < 3; j++) {
            getCofactor(matrix, temp, i, j, 3);
            sign = ((i + j) % 2 == 0) ? 1 : -1;
            adj[j][i] = (sign) * (determinant(temp, 3 - 1));
        }
    }
}

// Function to find the modular inverse of a number
int modInverse(int a, int m) {
    a = a % m;
    for (int x = 1; x < m; x++) {
        if ((a * x) % m == 1)
            return x;
    }
    return -1;
}

// Function to find the inverse of the key matrix
bool inverseKeyMatrix(int keyMatrix[3][3], int inverse[3][3]) {
    int det = determinant(keyMatrix, 3);
    int invDet = modInverse(det, 26);
    if (invDet == -1) {
        cout << "Inverse doesn't exist";
        return false;
    }

    int adj[3][3];
    adjoint(keyMatrix, adj);
    for (int i = 0; i < 3; i++) {
        for (int j = 0; j < 3; j++) {
            inverse[i][j] = (adj[i][j] * invDet) % 26;
            if (inverse[i][j] < 0) inverse[i][j] += 26;
        }
    }
    return true;
}

// Function to encrypt the message
```

```
void encrypt(int cipherMatrix[][1], int keyMatrix[][3], int messageVector[][1]) {
    for (int i = 0; i < 3; i++) {
        cipherMatrix[i][0] = 0;
        for (int j = 0; j < 3; j++) {
            cipherMatrix[i][0] += keyMatrix[i][j] * messageVector[j][0];
        }
        cipherMatrix[i][0] = cipherMatrix[i][0] % 26;
    }
}

// Function to decrypt the message
void decrypt(int plainMatrix[][1], int inverseKeyMatrix[][3], int cipherVector[][1]) {
    for (int i = 0; i < 3; i++) {
        plainMatrix[i][0] = 0;
        for (int j = 0; j < 3; j++) {
            plainMatrix[i][0] += inverseKeyMatrix[i][j] * cipherVector[j][0];
        }
        plainMatrix[i][0] = plainMatrix[i][0] % 26;
    }
}

// Function to implement Hill Cipher encryption
void HillCipherEncrypt(string message, string key) {
    int keyMatrix[3][3];
    getKeyMatrix(key, keyMatrix);

    // Pad the message to make its length a multiple of 3
    while (message.length() % 3 != 0) {
        message += 'X'; // Padding with 'X'
    }

    string CipherText;
    for (size_t i = 0; i < message.length(); i += 3) {
        int messageVector[3][1];
        for (int j = 0; j < 3; j++) {
            messageVector[j][0] = (message[i + j]) % 65;
        }

        int cipherMatrix[3][1];
        encrypt(cipherMatrix, keyMatrix, messageVector);

        for (int j = 0; j < 3; j++) {
            CipherText += cipherMatrix[j][0] + 65;
        }
    }

    // Print the ciphertext
    cout << "Ciphertext: " << CipherText << endl;
}
```

```
// Function to implement Hill Cipher decryption
void HillCipherDecrypt(string ciphertext, string key) {
    int keyMatrix[3][3];
    getKeyMatrix(key, keyMatrix);

    int inverseMatrix[3][3];
    if (!inverseKeyMatrix(keyMatrix, inverseMatrix)) {
        cout << "Key matrix is not invertible. Decryption aborted." << endl;
        return;
    }

    string PlainText;
    for (size_t i = 0; i < ciphertext.length(); i += 3) {
        int cipherVector[3][1];
        for (int j = 0; j < 3; j++) {
            cipherVector[j][0] = (ciphertext[i + j]) % 65;
        }

        int plainMatrix[3][1];
        decrypt(plainMatrix, inverseMatrix, cipherVector);

        for (int j = 0; j < 3; j++) {
            PlainText += plainMatrix[j][0] + 65;
        }
    }

    // Print the plaintext
    cout << "Plaintext: " << PlainText << endl;
}

int main() {
    string message;
    string key = "GYBNQKURP";

    cout << "Enter the message: ";
    getline(cin, message);

    HillCipherEncrypt(message, key);

    string ciphertext;
    cout << "Enter the ciphertext: ";
    getline(cin, ciphertext);

    HillCipherDecrypt(ciphertext, key);

    return 0;
}
```

Outputs :



```
Enter the message: BKL
Ciphertext: XXR
Enter the ciphertext: XXR
Plaintext: BKL
```