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Experiment 1	
AIM:	Implement different substitution techniques.
PROBLEM DEFINITION:	To implement all substitution encryption techniques namely Caesar Ciphers, Monoalphabetic Ciphers, Playfair Cipher, Hill Cipher and Polyalphabetic Ciphers. Then, perform ethical hacking on all substitution encryption techniques.
THEORY:	<p>Caesar Cipher</p> <p>The Caesar cipher is one of the simplest and oldest encryption techniques. It is a type of substitution cipher where each letter in the plaintext is shifted a certain number of places down or up the alphabet. For example, with a shift of 3, 'A' would be replaced by 'D', 'B' would become 'E', and so on. The key in a Caesar cipher is the number of positions each letter is shifted. Despite its simplicity, the Caesar cipher is not secure against modern cryptographic attacks.</p> <p>Monoalphabetic Cipher</p> <p>A monoalphabetic cipher is a substitution cipher where each letter in the plaintext is replaced by another letter from the alphabet. Unlike the Caesar cipher, which uses a fixed shift, a monoalphabetic cipher can use a more complex substitution pattern. Each letter in the plaintext is consistently replaced by the same letter in the ciphertext. This type of cipher is more secure than the Caesar cipher but is still vulnerable to frequency analysis.</p> <p>Playfair Cipher</p> <p>The Playfair cipher is a digraph substitution cipher that encrypts pairs of letters (digraphs) instead of single letters. It uses a 5x5 matrix (for a 26-letter alphabet, 'I' and 'J' are often combined) filled with a keyword and then the remaining letters of the alphabet. The encryption process involves replacing each pair of letters in the plaintext with another pair according to specific</p>

rules based on their positions in the matrix. The Playfair cipher is more secure than simple substitution ciphers but is still vulnerable to cryptanalysis.

Hill Cipher

The Hill cipher is a polygraphic substitution cipher that operates on blocks of letters rather than individual letters. It uses a matrix (usually 2x2 or 3x3) to encrypt the plaintext. Each block of letters is treated as a vector and multiplied by the encryption matrix modulo 26. The resulting vector is the ciphertext. The Hill cipher is more complex than simple substitution ciphers and provides better security, but it is still vulnerable to known-plaintext attacks.

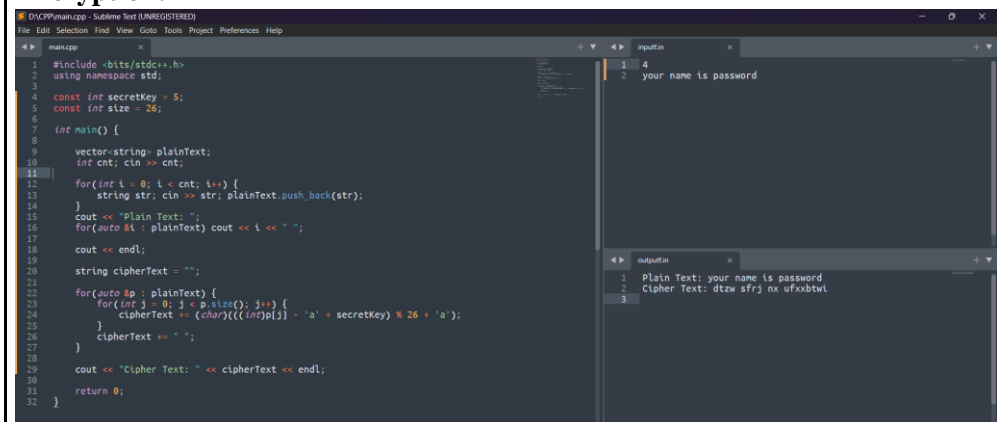
Polyalphabetic Cipher (Vigenère Cipher)

The Vigenère cipher is a method of encrypting alphabetic text by using a simple form of polyalphabetic substitution. It uses a keyword to determine the shift for each letter in the plaintext. For example, if the keyword is "LEMON" and the plaintext is "ATTACKATDAWN", the first letter 'A' is shifted by 'L' (11 positions), the second letter 'T' is shifted by 'E' (4 positions), and so on. The Vigenère cipher is more secure than monoalphabetic ciphers because it uses multiple substitution alphabets, making frequency analysis more difficult.

RESULT:

1. Caesar Cipher

Encryption:



```
1 #include <bits/stdc++.h>
2 using namespace std;
3
4 const int secretKey = 5;
5 const int size = 26;
6
7 int main() {
8     vector<string> plainText;
9     int cnt; cin >> cnt;
10
11     for(int i = 0; i < cnt; i++) {
12         string str; cin >> str; plainText.push_back(str);
13     }
14     cout << "Plain Text: ";
15     for(auto &i : plainText) cout << i << " ";
16     cout << endl;
17
18     string cipherText = "";
19
20     for(auto &p : plainText) {
21         for(int j = 0; j < p.size(); j++) {
22             cipherText += (char)((((int)p[j] - 'a' + secretKey) % 26 + 'a');
23         }
24         cipherText += " ";
25     }
26
27     cout << "Cipher Text: " << cipherText << endl;
28     return 0;
29 }
```

input.txt

```
1 4
2 your name is password
```

output.txt

```
1 Plain Text: your name is password
2 Cipher Text: dtzw sfrj nx ufxxbtwl
3
```

Decryption:

```

D:\CPP\Programs - Sublime Text (UNREGISTERED)
File Edit Selection Find View Goto Tools Project Preferences Help

main.cpp
1 #include <bits/stdc++.h>
2 using namespace std;
3
4
5 int main() {
6     // input
7     vector<string> cipherText;
8     int cnt; cin >> cnt;
9
10    for(int i = 0; i < cnt; i++) {
11        string str; cin >> str; cipherText.push_back(str);
12    }
13    cout << "Cipher Text: ";
14    for(auto &1 : cipherText) cout << i << " ";
15
16    cout << endl;
17
18    // brute force
19    for(int secretKey = 1; secretKey <= 26; secretKey++) {
20        string plainText = "";
21        for(auto &c : cipherText) {
22            for(int i = 0; i < c.size(); i++) {
23                int d = (int)c[i] - 'a' - (secretKey);
24                if(d < 0) d += 26;
25                plainText += (char)((d + 26) % 26 + 'a');
26            }
27            plainText += " ";
28        }
29        cout << "For key: " << secretKey << " [Plain Text: " << plainText << endl;
30    }
31    return 0;
32 }
33 }

[Finished in 1.1s]

```

```

1 4
2 dtzw sfrj nx ufxxbtwl

Cipher Text: dtzw sfrj nx ufxxbtwl
For key: 1 Plain Text: csyv reqi nw towasvsh
For key: 2 Plain Text: brxu qdoh lv soovzrug
For key: 3 Plain Text: qout pooo ku rcouyctf
For key: 4 Plain Text: zpvs obnf jt qbttxpse
For key: 5 Plain Text: your name is password
For key: 6 Plain Text: vntq nclb hr ozrrvncs
For key: 7 Plain Text: wmsp lykc qg nyqoumb
For key: 8 Plain Text: vlro kxjb fp nxaptloa
For key: 9 Plain Text: ukun jwln en lnooskoz
For key: 10 Plain Text: tjpn lvhz dn kvnerjny
For key: 11 Plain Text: stol hugy cn jumnglix
For key: 12 Plain Text: rhnk gtrf bl lllplhw
For key: 13 Plain Text: ognj faew ak hskkogiv
For key: 14 Plain Text: prll ardv zj grjnjfuw
For key: 15 Plain Text: oakh dqcu yl fqltweht
For key: 16 Plain Text: ndjg cbpt xh ephldgs
For key: 17 Plain Text: ncif boas wg doggkcfrr
For key: 18 Plain Text: lthe anar vf cffjbeq
For key: 19 Plain Text: kagd znyq ue bneeladp
For key: 20 Plain Text: jffc ylxp td alldhzco
For key: 21 Plain Text: lyeb akwo sc zccogynb
For key: 22 Plain Text: hwsd wjvn rb yjbbfxam
For key: 23 Plain Text: gwcz viun qa xiaawzwl
For key: 24 Plain Text: fvby uhnl pz whzdyvk
For key: 25 Plain Text: quas tpsk oy vpyxcuj
For key: 26 Plain Text: dtzw sfrj nx ufxxbtwl

```

2. Monoalphabetic Substitution

Encryption:

```

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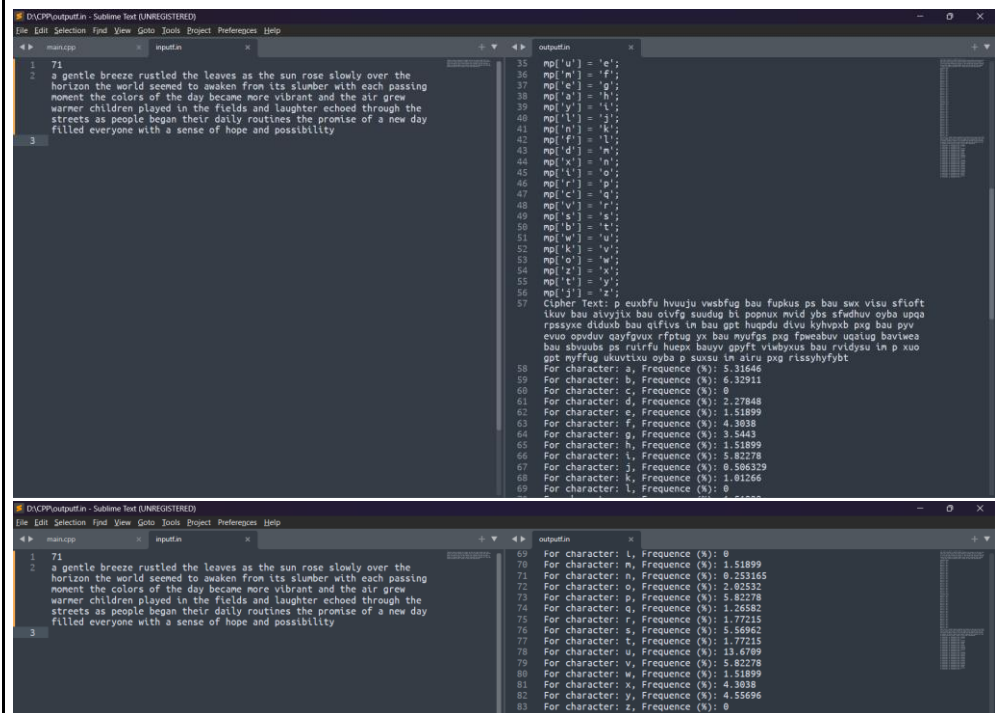
main.cpp
1 71
2 a gentle breeze rustled the leaves as the sun rose slowly over the
3 horizon the world seemed to awaken from its slumber with each passing
moment the colors of the day became more vibrant and the air grew
warmer children played in the fields and laughter echoed through the
streets as people began their daily routines the promise of a new day
filled everyone with a sense of hope and possibility

input
1 Enter count of words in plain text: 71
2 Plain text entered: a gentle breeze rustled the leaves as the sun rose
slowly over the horizon the world seemed to awaken from its slumber
with each passing moment the colors of the day became more vibrant and
the air grew warmer children played in the fields and laughter echoed
through the streets as people began their daily routines the promise
of a new day filled everyone with a sense of hope and possibility

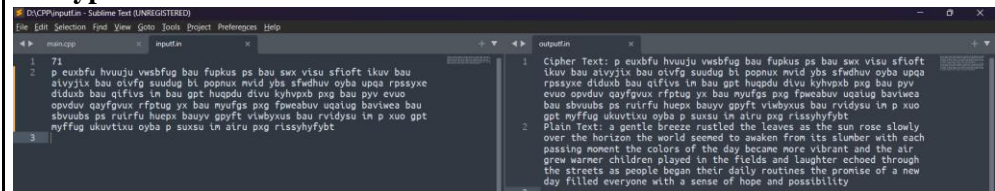
3 Encryption key:
4 mp['a'] = 'p';
5 mp['b'] = 'h';
6 mp['c'] = 'g';
7 mp['d'] = 'q';
8 mp['e'] = 's';
9 mp['f'] = 'm';
10 mp['g'] = 'e';
11 mp['h'] = 'a';
12 mp['i'] = 'v';
13 mp['j'] = 'l';
14 mp['k'] = 'n';
15 mp['l'] = 'f';
16 mp['m'] = 'd';
17 mp['n'] = 'x';
18 mp['o'] = 't';
19 mp['p'] = 'r';
20 mp['q'] = 'c';
21 mp['r'] = 'w';
22 mp['s'] = 'i';
23 mp['t'] = 'b';
24 mp['u'] = 'u';
25 mp['v'] = 'k';
26 mp['w'] = 'o';
27 mp['x'] = 'z';
28 mp['y'] = 'j';
29 mp['z'] = 'y';
30 Decryption key:
31 mp['p'] = 'a';
32 mp['h'] = 'b';
33 mp['g'] = 'c';
34 mp['q'] = 'd';
35 mp['s'] = 'e';

[Finished in 1.6s]

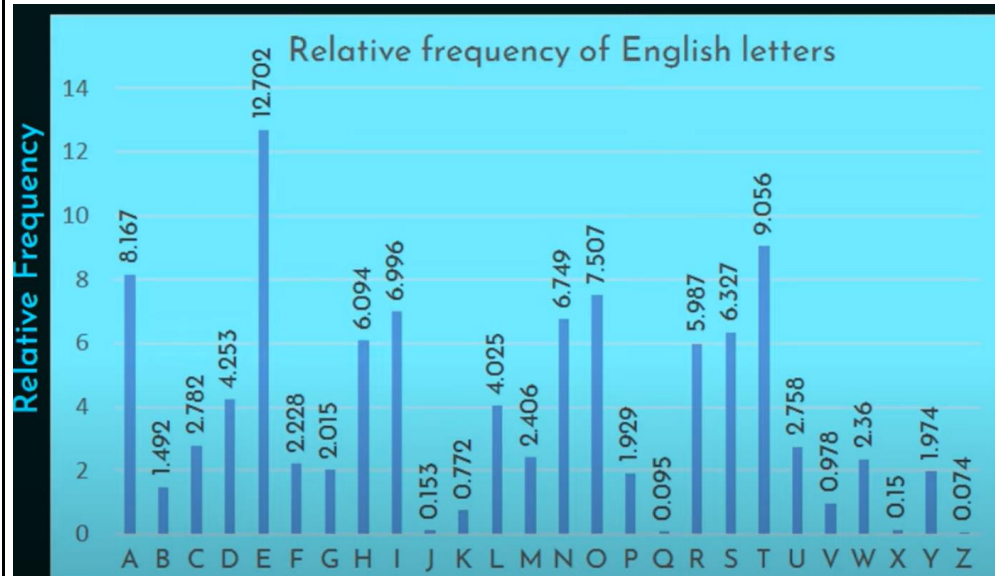
```

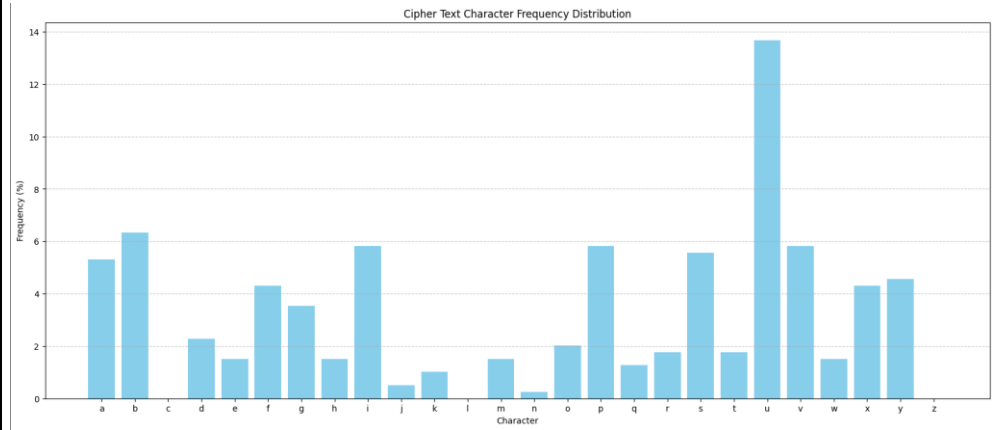


Decryption:



Cryptanalysis:





3. Playfair Cipher

Encryption:

```

1 1
2 greet

```

```

1 Plain text entered: greet
2
3 Keyword: moonmission
4
5 Matrix generated:
6 m o n l s
7 a b c d e
8 f g h k l
9 p q r t u
10 v x y z
11
12 Plain text pairs generated: gr ex et
13 Cipher text generated: hq cz du

```

Decryption:

```

1 3
2 hq cz du
3
4 m o n l s
5 a b c d e
6 f g h k l
7 p q r t u
8 v x y z
9

```

```

1 Cipher text entered: hq cz du
2
3 Matrix entered:
4 m o n l s
5 a b c d e
6 f g h k l
7 p q r t u
8 v x y z
9 Plain text: greet

```

4. Hill Cipher

Encryption:

```

1 #include <bits/stdc++.h>
2 using namespace std;
3
4
5 const string key = "gybnqkurlp";
6 const int block = 3;
7 const int mod26 = 26;
8
9 string findCipher(vector<vector<int>> &keyMatrix, string &plainText) {
10     vector<vector<int>> plainTextVector(1, vector<int>(block));
11     for(int i = 0; i < plainText.size(); i++) {
12         plainTextVector[0][i] = plainText[i] - 'a';
13     }
14
15     string cipherTextVector = "";
16     for(int col = 0; col < block; col++) {
17         int sum = 0;
18         for(int row = 0; row < block; row++) {
19             sum = (sum + plainTextVector[0][row] * keyMatrix[row][col]) % mod26;
20         }
21         cipherTextVector += char(sum + 'a');
22     }
23
24     return cipherTextVector;
25 }
26
27 int main() {
28     int cnt;
29     cout << "Enter word count in plain text: ";
30     cin >> cnt;
31     cout << cnt << endl << endl;
32
33     vector<string> plainText;
34     string plainTextNoSpace;
35     for(int i = 0; i < cnt; i++) {
36         string s; cin >> s;
37         plainText.push_back(s);
38         plainTextNoSpace += s;
39     }
40
41     [Finished in 1.9s]

```

```

1 3
2 pay more money

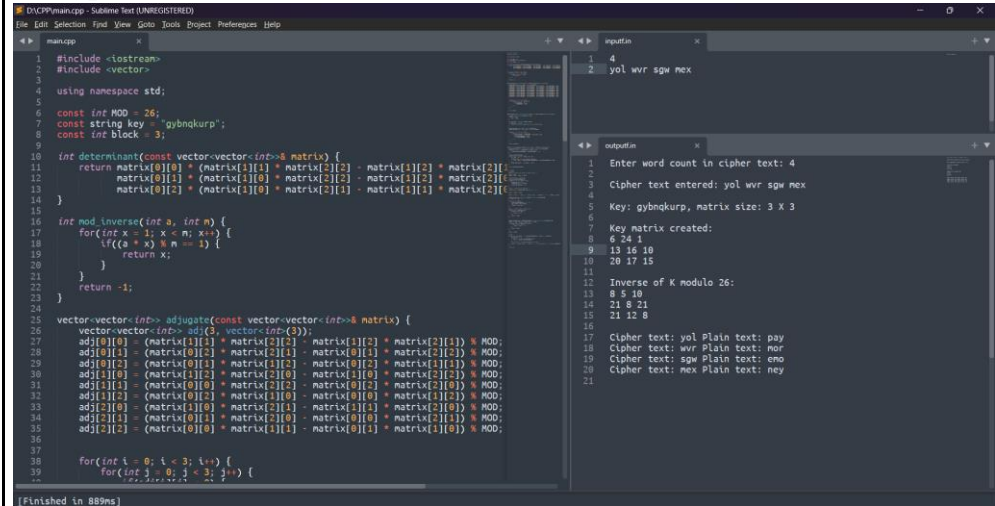
```

```

1 Enter word count in plain text: 3
2 Plain text entered: pay more money
3
4 Key: gybnqkurlp, Matrix size: 3 X 3
5
6 Key matrix created:
7 6 24 1
8 13 16 18
9 20 17 15
10
11 Plain text: pay Cipher text: yol
12 Plain text: mor Cipher text: wvr
13 Plain text: omo Cipher text: sqw
14 Plain text: ney Cipher text: nex

```

Decryption:



```
#include <iostream>
#include <vector>
using namespace std;
const int MOD = 26;
const string key = "gybnqkurlp";
const int block = 3;

int determinant(const vector<vector<int>>& matrix) {
    return matrix[0][0] * (matrix[1][1] * matrix[2][2] - matrix[1][2] * matrix[2][1]) -
           matrix[0][1] * (matrix[1][0] * matrix[2][2] - matrix[1][2] * matrix[2][0]) +
           matrix[0][2] * (matrix[1][0] * matrix[2][1] - matrix[1][1] * matrix[2][0]);
}

int mod_inverse(int a, int m) {
    for(int x = 1; x < m; x++) {
        if((a * x) % m == 1) {
            return x;
        }
    }
    return -1;
}

vector<vector<int>> adjugate(const vector<vector<int>>& matrix) {
    vector<vector<int>> adj(3, vector<int>(3));
    adj[0][0] = (matrix[1][1] * matrix[2][2] - matrix[1][2] * matrix[2][1]) % MOD;
    adj[0][1] = (matrix[0][1] * matrix[2][2] - matrix[0][2] * matrix[2][1]) % MOD;
    adj[0][2] = (matrix[0][0] * matrix[2][2] - matrix[0][2] * matrix[2][0]) % MOD;
    adj[1][0] = (matrix[1][2] * matrix[2][0] - matrix[1][0] * matrix[2][2]) % MOD;
    adj[1][1] = (matrix[0][0] * matrix[2][0] - matrix[0][1] * matrix[2][0]) % MOD;
    adj[1][2] = (matrix[0][1] * matrix[2][0] - matrix[0][0] * matrix[2][0]) % MOD;
    adj[2][0] = (matrix[1][0] * matrix[2][1] - matrix[1][1] * matrix[2][0]) % MOD;
    adj[2][1] = (matrix[0][0] * matrix[2][1] - matrix[0][0] * matrix[2][1]) % MOD;
    adj[2][2] = (matrix[0][0] * matrix[2][1] - matrix[0][1] * matrix[2][1]) % MOD;

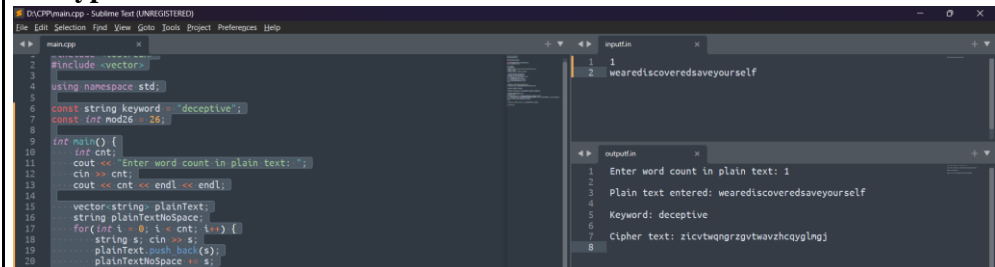
    for(int i = 0; i < 3; i++) {
        for(int j = 0; j < 3; j++) {
            adj[i][j] = adj[j][i];
        }
    }
}
```

Input: 4
yol wvr spw mex

Output: Enter word count in cipher text: 4
Cipher text entered: yol wvr spw mex
Key: gybnqkurlp, Matrix size: 3 X 3
Key matrix created:
6 24 1
13 16 18
20 17 15
Inverse of K modulo 26:
8 5 10
21 8 21
21 12 8
Cipher text: yol Plain text: pay
Cipher text: wvr Plain text: nor
Cipher text: spw Plain text: eno
Cipher text: mex Plain text: ney

5. Polyalphabetic Cipher

Encryption:



```
#include <vector>
using namespace std;
const string keyword = "deceptive";
const int mod26 = 26;

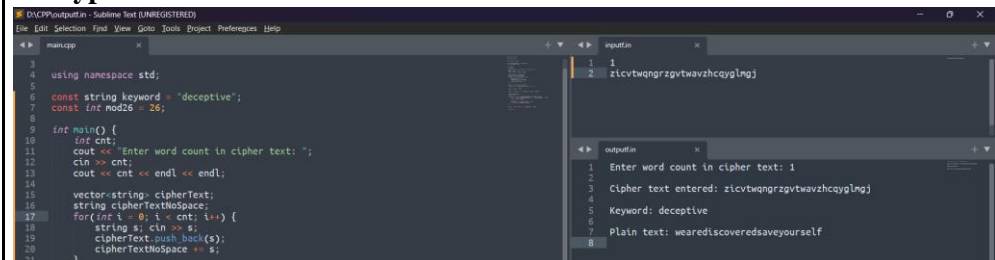
int main() {
    int cnt;
    cout << "Enter word count in plain text: ";
    cin >> cnt;
    cout << cnt << endl << endl;

    vector<string> plainText;
    string plainTextNoSpace;
    for(int i = 0; i < cnt; i++) {
        string s; cin >> s;
        plainText.push_back(s);
        plainTextNoSpace += s;
    }
}
```

Input: 1
wearediscoveredsaveyourself

Output: Enter word count in plain text: 1
Plain text entered: wearediscoveredsaveyourself
Keyword: deceptive
Cipher text: zlcvtwqngzrgvtwvzhcayglnj

Decryption:



```
#include <vector>
using namespace std;
const string keyword = "deceptive";
const int mod26 = 26;

int main() {
    int cnt;
    cout << "Enter word count in cipher text: ";
    cin >> cnt;
    cout << cnt << endl << endl;

    vector<string> cipherText;
    string cipherTextNoSpace;
    for(int i = 0; i < cnt; i++) {
        string s; cin >> s;
        cipherText.push_back(s);
        cipherTextNoSpace += s;
    }
}
```

Input: 1
zlcvtwqngzrgvtwvzhcayglnj

Output: Enter word count in cipher text: 1
Cipher text entered: zlcvtwqngzrgvtwvzhcayglnj
Keyword: deceptive
Plain text: wearediscoveredsaveyourself

CONCLUSION:

Through this experiment, I explored and implemented various substitution encryption techniques, including Caesar cipher, Monoalphabetic cipher, Playfair cipher, Hill cipher, and Polyalphabetic (Vigenère) cipher. This hands-on experience provided a comprehensive understanding of how these algorithms function and how they can be applied to convert plaintext into ciphertext and vice versa.