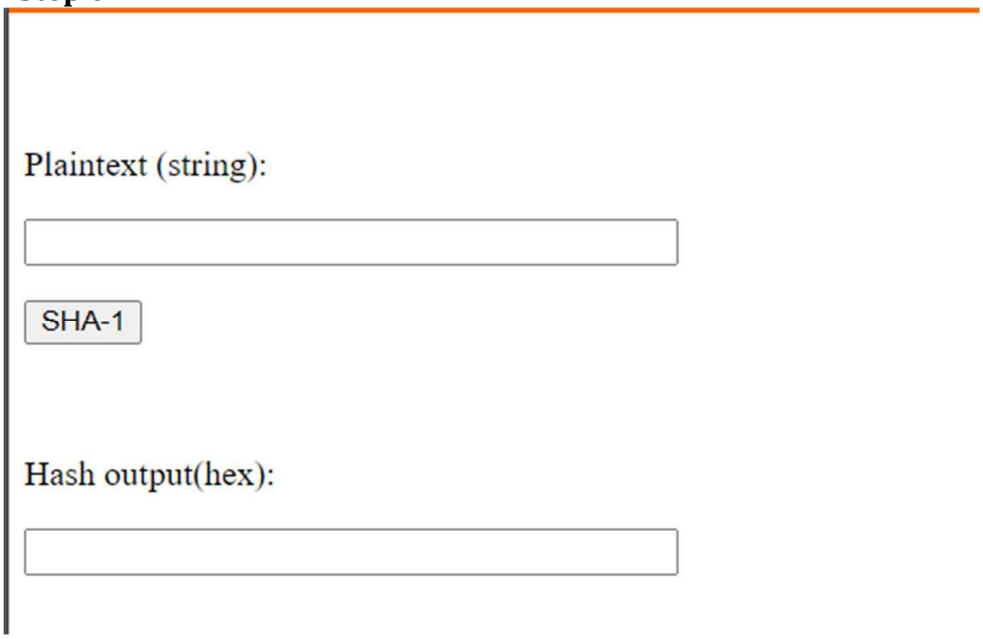
Lab#1 Implement Caesar cipher encryption-decryption. Perform in PYTHON as well as in Virtual lab.

Virtual Lab Simulator:

https://virtual-labs.github.io/exp-digital-signatures-iiith/simulation.html

Step 0:



Step 1: Enter the Plain Text.

Step 2: Generate the Hash Output for SHA - 1.

PART III

Plaintext:

Suraj Kumar

shift: 3

v Encrypt v ^ Decrypt ^

Ciphertext

vxudm nxpdu

Outcome: -

PROBLEMS OUTPUT DEBUG CONSOLE PORTS TERMINAL

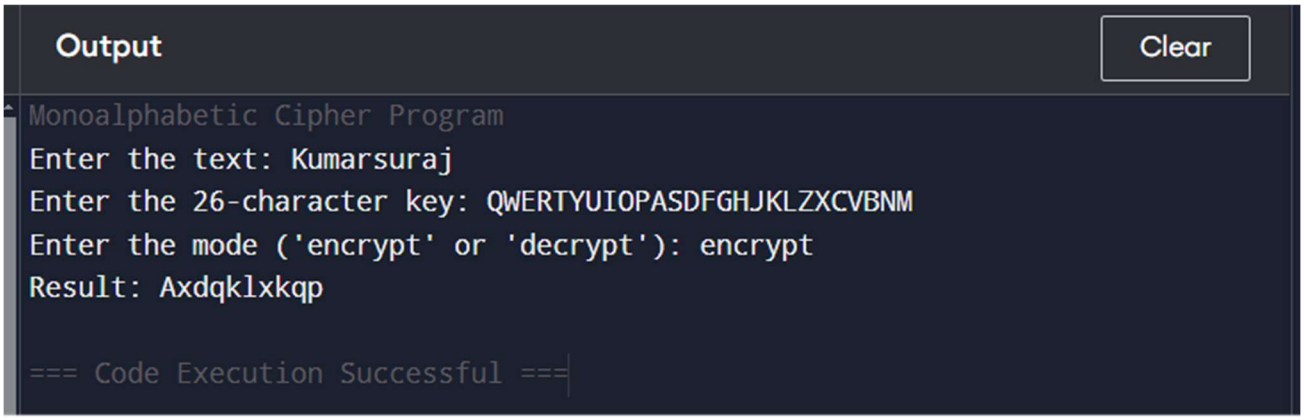
```
Caesar Cipher Program
Enter the text: Suraj Kumar
Enter the shift value: 3
Enter the mode ('encrypt' or 'decrypt'): encrypt
Result: Vxudm Nxpdu
PS D:\Python\CODE> python CaeserCipher.py
Caesar Cipher Program
Enter the text: Vxudm Nxpdu
Enter the shift value: 3
Enter the mode ('encrypt' or 'decrypt'): decrypt
Result: Suraj Kumar
PS D:\Python\CODE>
```

Code Snippet:

```
# Caesar Cipher Implementation in Python with User Input and Switch-Case

def caesar_cipher(text, shift, mode):
    # Normalize shift to handle negative values or values greater than 26
    shift = shift % 26
    if shift < 0:
        shift += 26

    def shift_char(char, shift_amount):
        if 'A' <= char <= 'Z':
            return chr(((ord(char) - 65 + shift_amount) % 26) + 65)
        elif 'a' <= char <= 'z':
            return chr(((ord(char) - 97 + shift_amount) % 26) + 97)
        else:
            return char  # Non-alphabetical characters remain unchanged

    match mode:  # Using Python's match-case for switch-case behavior
        case 'encrypt':
            return ''.join(shift_char(char, shift) for char in text)
        case 'decrypt':
            return ''.join(shift_char(char, -shift) for char in text)
        case _:
            raise ValueError("Invalid mode. Use 'encrypt' or 'decrypt'.")

# Main program for user input
if __name__ == "__main__":
    print("Caesar Cipher Program")
    text = input("Enter the text: ")
    try:
        shift = int(input("Enter the shift value: "))
    except ValueError:
        print("Shift must be an integer.")
        exit()

    mode = input("Enter the mode ('encrypt' or 'decrypt'): ").strip().lower()

    try:
        result = caesar_cipher(text, shift, mode)
        print(f"Result: {result}")
    except ValueError as e:
        print(e)
```

Lab#2 Implement Monoalphabetic cipher encryption-decryption. Perform in PYTHON.

Outcome: -



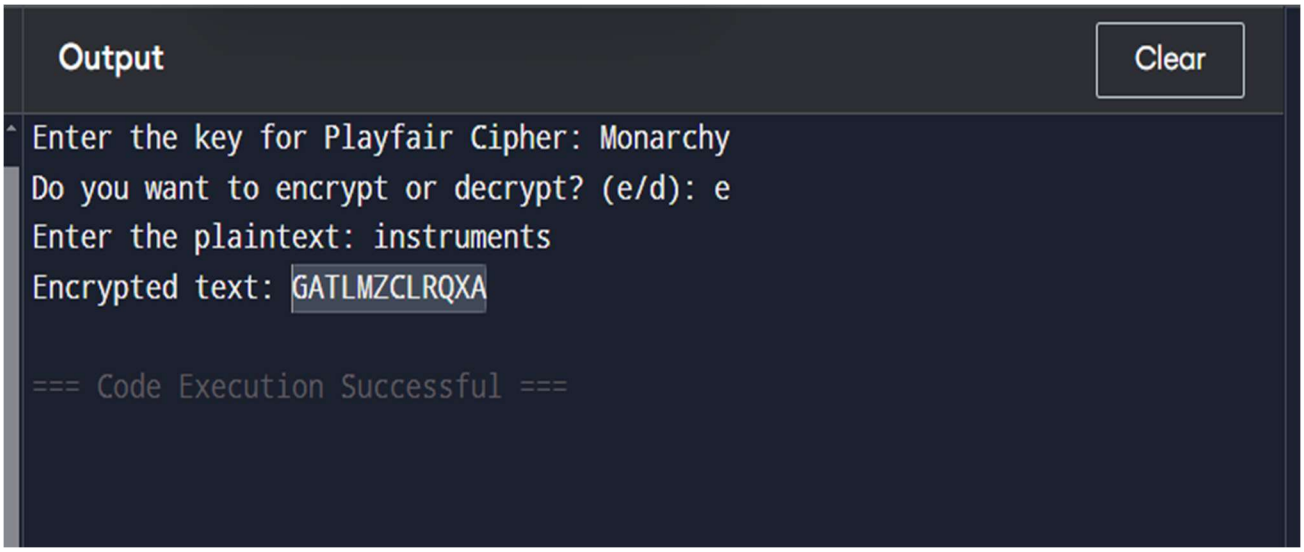

```
# Monoalphabetic Cipher Implementation in Python with Switch-Case

def monoalphabetic_cipher(text, key, mode):
    # Define the alphabet
    alphabet = 'ABCDEFGHIJKLMNOPQRSTUVWXYZ'
    key = key.upper()

    if len(set(key)) != 26 or not key.isalpha():
        raise ValueError("Key must be a 26-character unique alphabet string.")

    def encrypt_char(char):
        if char.isalpha():
            idx = alphabet.index(char.upper())
            return key[idx] if char.isupper() else key[idx].lower()
        else:
            return char

    def decrypt_char(char):
        if char.isalpha():
            idx = key.index(char.upper())
            return alphabet[idx] if char.isupper() else alphabet[idx].lower()
        else:
```

```
            return char

    match mode:  # Using Python's match-case for switch-case behavior
        case 'encrypt':
            return ''.join(encrypt_char(char) for char in text)
        case 'decrypt':
            return ''.join(decrypt_char(char) for char in text)
        case _:
            raise ValueError("Invalid mode. Use 'encrypt' or 'decrypt'.")

# Main program for user input
if __name__ == "__main__":
    print("Monoalphabetic Cipher Program")
    text = input("Enter the text: ")
    key = input("Enter the 26-character key: ").strip()
    mode = input("Enter the mode ('encrypt' or 'decrypt'): ").strip().lower()

    try:
        result = monoalphabetic_cipher(text, key, mode)
        print(f"Result: {result}")
    except ValueError as e:
        print(e)
```

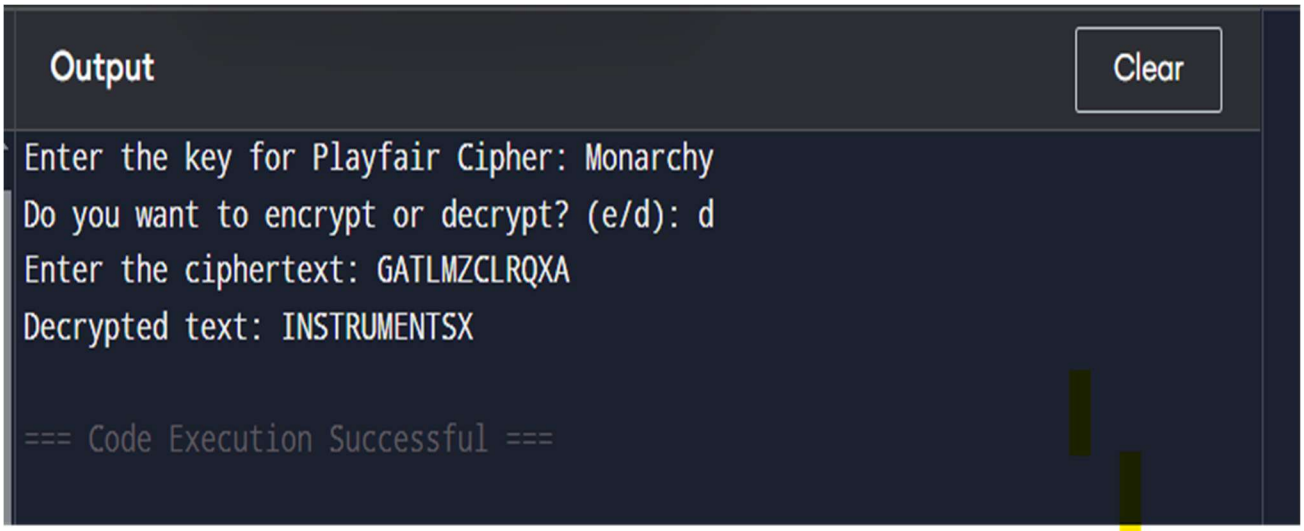
Lab#3 Implement Playfair cipher encryption-decryption. Perform in PYTHON.

Outcome: -

ENCRYPTION: -



DECRPTION: -



CODE: -

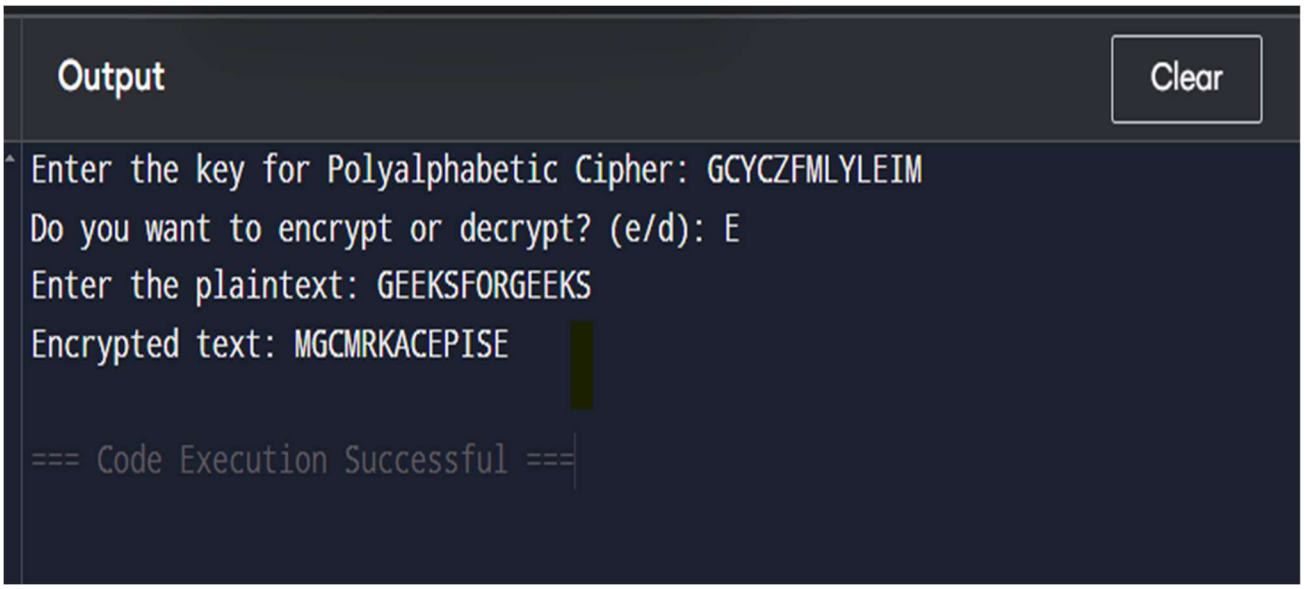
```
def create_matrix(key):
    # Remove duplicates and replace J with I
    key = key.upper().replace('J', 'I')
    key = "".join(sorted(set(key), key=key.index))

    # Create the matrix
    alphabet = "ABCDEFGHIKLMNOPQRSTUVWXYZ"
    matrix = [c for c in key if c in alphabet] + [c for c in alphabet if c not in key]

    return [matrix[i:i+5] for i in range(0, 25, 5)]

def find_position(matrix, char):
    for row_idx, row in enumerate(matrix):
        if char in row:
            return row_idx, row.index(char)
    return None

def prepare_text(text, for_encryption=True):
    text = text.upper().replace("J", "I")
    result = ""

    i = 0
    while i < len(text):
        a = text[i]
        b = text[i+1] if i + 1 < len(text) else ""

        if for_encryption and a == b:
            result += a + "X"
            i += 1
        elif b == "":
            result += a + "X"
            i += 1
        else:
            result += a + b
            i += 2

    return result

def encrypt_pair(pair, matrix):
    r1, c1 = find_position(matrix, pair[0])
    r2, c2 = find_position(matrix, pair[1])

    if r1 == r2:  # Same row
        return matrix[r1][(c1 + 1) % 5] + matrix[r2][(c2 + 1) % 5]
    elif c1 == c2:  # Same column
        return matrix[(r1 + 1) % 5][c1] + matrix[(r2 + 1) % 5][c2]
    else:  # Rectangle
        return matrix[r1][c2] + matrix[r2][c1]
```

```
def decrypt_pair(pair, matrix):
    r1, c1 = find_position(matrix, pair[0])
    r2, c2 = find_position(matrix, pair[1])

    if r1 == r2:  # Same row
        return matrix[r1][(c1 - 1) % 5] + matrix[r2][(c2 - 1) % 5]
    elif c1 == c2:  # Same column
        return matrix[(r1 - 1) % 5][c1] + matrix[(r2 - 1) % 5][c2]
    else:  # Rectangle
        return matrix[r1][c2] + matrix[r2][c1]

def playfair_encrypt(plaintext, key):
    matrix = create_matrix(key)
    plaintext = prepare_text(plaintext, for_encryption=True)

    ciphertext = ""
    for i in range(0, len(plaintext), 2):
        ciphertext += encrypt_pair(plaintext[i:i+2], matrix)

    return ciphertext

def playfair_decrypt(ciphertext, key):
    matrix = create_matrix(key)

    plaintext = ""
    for i in range(0, len(ciphertext), 2):
        plaintext += decrypt_pair(ciphertext[i:i+2], matrix)

    return plaintext

if __name__ == "__main__":
    key = input("Enter the key for Playfair Cipher: ")
    choice = input("Do you want to encrypt or decrypt? (e/d): ").lower()

    if choice == "e":
        plaintext = input("Enter the plaintext: ")
        ciphertext = playfair_encrypt(plaintext, key)
        print(f"Encrypted text: {ciphertext}")
    elif choice == "d":
        ciphertext = input("Enter the ciphertext: ")
        plaintext = playfair_decrypt(ciphertext, key)
        print(f"Decrypted text: {plaintext}")
    else:
        print("Invalid choice!")
```

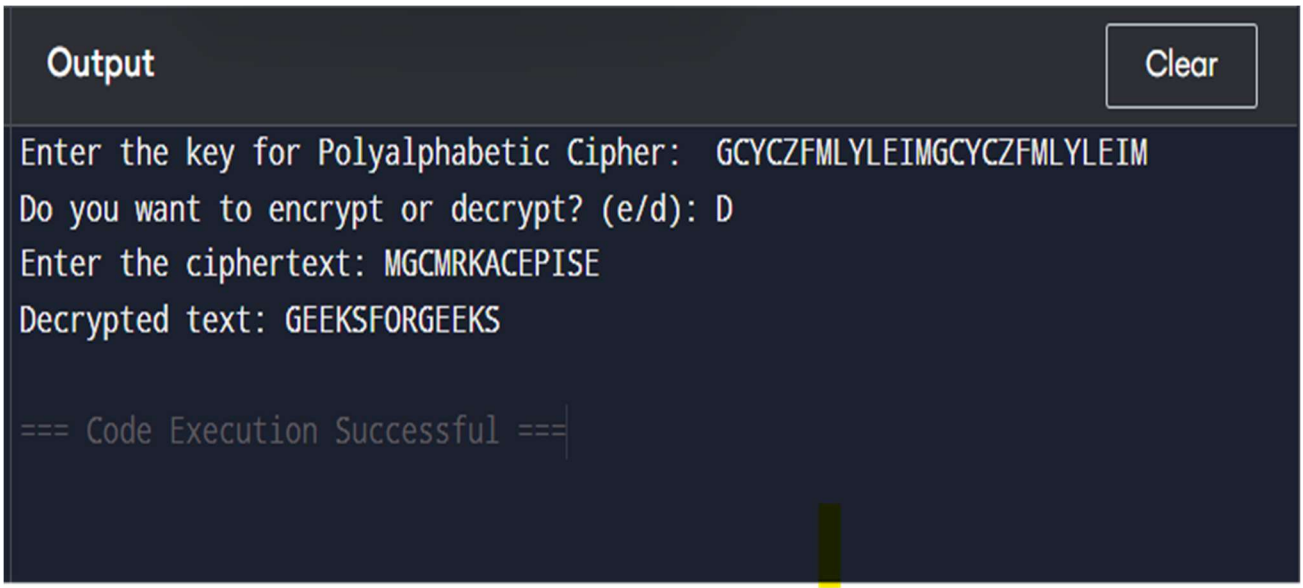
Lab#4 Implement Polyalphabetic cipher encryption-decryption. Perform in PYTHON.

Outcome: -

ENCRYPTION: -



DECRYPTION: -



CODE: -

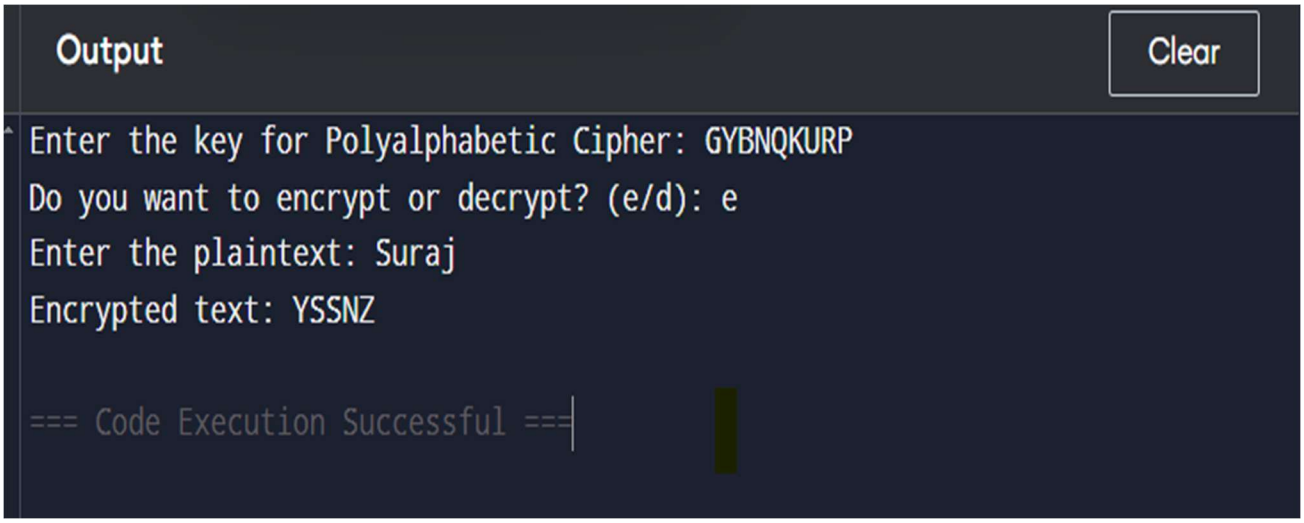
```
def generate_vigenere_table():
    table = []
    for i in range(26):
        row = [chr((i + j) % 26 + 65) for j in range(26)]
        table.append(row)
    return table

def vigenere_encrypt(plaintext, key):
    table = generate_vigenere_table()
    plaintext = plaintext.upper()
    key = key.upper()

    ciphertext = ""
    key_index = 0

    for char in plaintext:
        if char.isalpha():
            row = ord(key[key_index]) - 65
            col = ord(char) - 65
        ciphertext += table[row][col]
            key_index = (key_index + 1) % len(key)
        else:
            ciphertext += char

    return ciphertext

def vigenere_decrypt(ciphertext, key):
    table = generate_vigenere_table()
    ciphertext = ciphertext.upper()
    key = key.upper()

    plaintext = ""
    key_index = 0

    for char in ciphertext:
        if char.isalpha():
            row = ord(key[key_index]) - 65
            col = table[row].index(char)
            plaintext += chr(col + 65)
            key_index = (key_index + 1) % len(key)
        else:
            plaintext += char
```

```
    return plaintext

if __name__ == "__main__":
    key = input("Enter the key for Polyalphabetic Cipher: ")
    choice = input("Do you want to encrypt or decrypt? (e/d): ").lower()

    if choice == "e":
        plaintext = input("Enter the plaintext: ")
        ciphertext = vigenere_encrypt(plaintext, key)
        print(f"Encrypted text: {ciphertext}")
    elif choice == "d":
        ciphertext = input("Enter the ciphertext: ")
        plaintext = vigenere_decrypt(ciphertext, key)
        print(f"Decrypted text: {plaintext}")
    else:


        print("Invalid choice!")
```

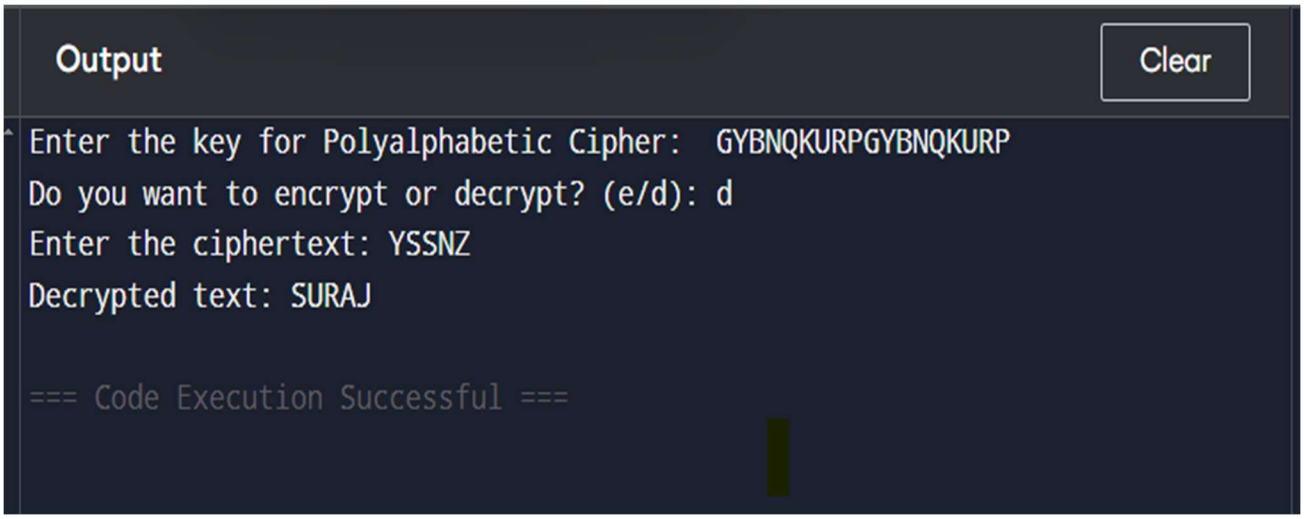
Lab#5 Implement Hill cipher encryption-decryption. Perform in PYTHON.

Outcome: -

ENCRYPTION: -



DECRYPTION: -



CODE: -

```
def generate_vigenere_table():
    table = []
    for i in range(26):
        row = [chr((i + j) % 26 + 65) for j in range(26)]
        table.append(row)
    return table

def vigenere_encrypt(plaintext, key):
    table = generate_vigenere_table()
    plaintext = plaintext.upper()
    key = key.upper()

    ciphertext = ""
    key_index = 0

    for char in plaintext:
        if char.isalpha():
            row = ord(key[key_index]) - 65
            col = ord(char) - 65
            ciphertext += table[row][col]
            key_index = (key_index + 1) % len(key)
        else:
            ciphertext += char

    return ciphertext

def vigenere_decrypt(ciphertext, key):
    table = generate_vigenere_table()
    ciphertext = ciphertext.upper()
    key = key.upper()

    plaintext = ""
    key_index = 0

    for char in ciphertext:
        if char.isalpha():
            row = ord(key[key_index]) - 65
            col = table[row].index(char)
            plaintext += chr(col + 65)
            key_index = (key_index + 1) % len(key)
        else:
            plaintext += char
```

```
return plaintext

if __name__ == "__main__":
    key = input("Enter the key for Polyalphabetic Cipher: ")
    choice = input("Do you want to encrypt or decrypt? (e/d): ").lower()

    if choice == "e":
        plaintext = input("Enter the plaintext: ")
        ciphertext = vigenere_encrypt(plaintext, key)
        print(f"Encrypted text: {ciphertext}")
    elif choice == "d":
        ciphertext = input("Enter the ciphertext: ")
        plaintext = vigenere_decrypt(ciphertext, key)
        print(f"Decrypted text: {plaintext}")
    else:
        print("Invalid choice!")
```

Lab#6 Case Study on: Simple DES prepare report

1. Introduction:

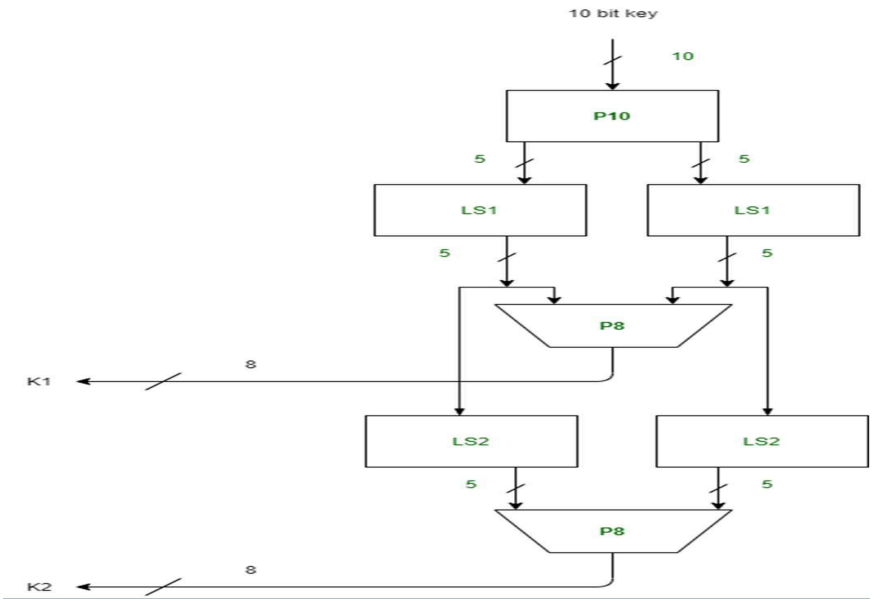
The Data Encryption Standard (DES) has played a pivotal role in the history of symmetric-key cryptography. However, due to its complexity and security vulnerabilities, a simplified version—Simple DES (S-DES)—has been developed to help students and researchers understand the fundamentals of encryption without the overhead of industrial-grade systems. S-DES operates on 8-bit plaintext blocks using a 10-bit key, incorporating key generation, permutations, substitutions, and Feistel rounds. This lab report provides an in-depth analysis of S-DES, covering its design, operation, and educational benefits.

2. Objectives:

- Understand the DES Structure: Analyses the structure of DES and its simplified version, S-DES.
- Implement S-DES: Develop the key generation, encryption, and decryption routines.
- Examine Cryptographic Processes: Explore how permutations, substitutions, and XOR operations secure data.
- Validate Reversibility: Ensure that the encryption process can be reversed to recover the original plaintext.
- Discuss Educational Implications: Evaluate the benefits and limitations of S-DES as an instructional model.

3. 3. Methodology

4. 3.1 Diagram of the S-DES Process



3.2OverView of DES:

Simple DES (S-DES) is a compact block cipher that encrypts 8-bit plaintext using a 10-bit key. Its structure mirrors that of DES but with reduced complexity:

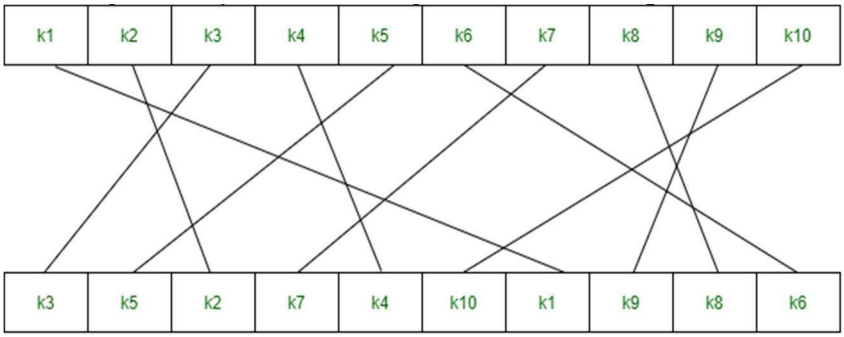
- Initial Permutation (IP): Rearranges the bits of the plaintext.
- Feistel Rounds: Two rounds of processing using subkeys (K_1 and K_2) derived from the main key.
- Switching Function: A swap operation between rounds that interleaves the data halves.
- Inverse Initial Permutation (IP^{-1}): Reverses the initial permutation to produce the ciphertext.

3.3 Key Generation:

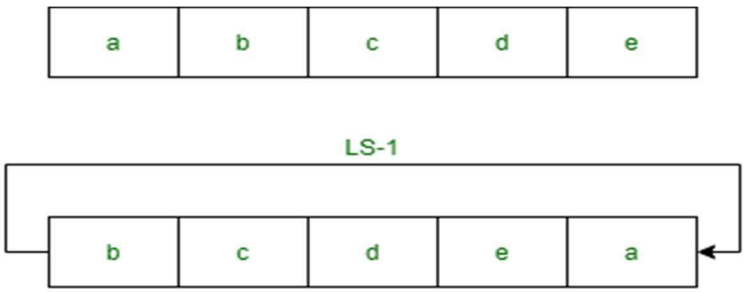
The 10-bit key is transformed into two 8-bit subkeys (K_1 and K_2) through the following steps:

3.3.1 Permutation P10:

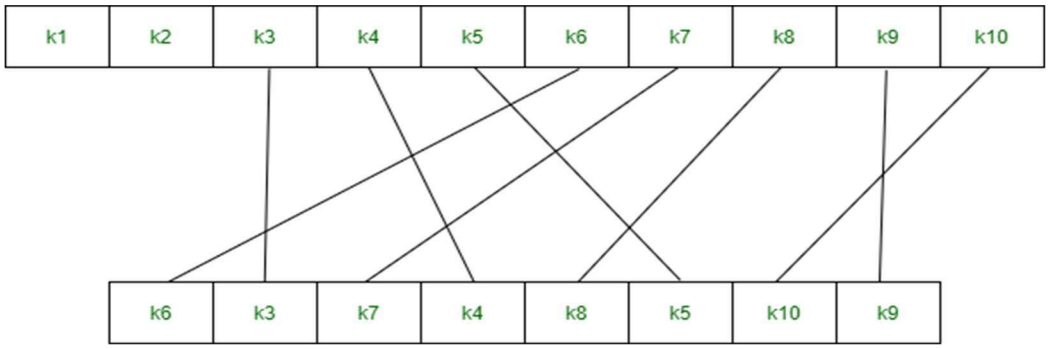
Rearrange the key bits according to a fixed 10-bit permutation table.



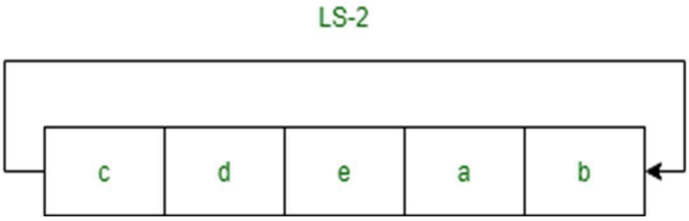
5. **Left Shift (LS-1):**
   Split the permuted key into two 5-bit halves and perform a circular left shift by one position on each half.



6. **Permutation P8 for K_1:**
   Combine the shifted halves and permute them using a fixed 8-bit table to generate subkey K_1.



7. **Left Shift (LS-2):**
   Shift each 5-bit half two positions to the left.



8. **Permutation P8 for K_2:**

   Combine the shifted halves and apply the P8 permutation again to generate subkey K_2.

3.4 **The Encryption Process:**
The encryption process in S-DES consists of the following steps:

1. Initial Permutation (IP): The 8-bit plaintext is permuted using a predefined table.
2. Splitting: The permuted text is divided into two 4-bit halves, labelled L (left) and R (right).
3. Round 1 (Using K_1):
Detailed Feistel Function Sub-steps:

- **Divide the plaintext:** Split into L and R.
- **Expansion Permutation (EP):** Expand the 4-bit R to a 6-bit value by rearranging and duplicating certain bits.
- **Key Mixing:** OR the expanded R with subkey K_1.
- **Substitution using S-Boxes:**
  - Divide the 6-bit result into two parts.
  - Input the left part to S-Box S1 and the right part to S-Box S2.
  - Each S-Box outputs 2 bits.

- **Combine and Permutation P4:**
  - Combine the two 2-bit outputs to form a 4-bit value.
  - Permute the 4-bit result using the P4 permutation table.
- **Final XOR:** XOR the P4 output with the left half L.
- **Swap:** Exchange the two halves to prepare for the next round.

4. Round 2 (Using K_2): Repeat the Feistel function using subkey K_2 on the new right half. In this round, the final swap is omitted.

5. **Inverse Permutation (IP^{-1}):** The final combination of the two halves is passed through the nverse initial permutation to produce the ciphertext.

3.5 The Round Function fK:

The round function fK plays a central role in the encryption process:

- Expansion/Permutation (EP):

Expand the 4-bit input (from R) to 6 bits.

- Key Mixing: XOR the expanded bits with the corresponding subkey.
- Substitution using S-Boxes: Split the result and process each half through its respective S-Box (S1 and S2) to obtain 2-bit outputs.

- Permutation P4: Combine and rearrange the outputs into a 4-bit value.
- Final XOR: XOR the P4 result with the left half of the data block.

3.6 **The Decryption Process**

Decryption mirrors the encryption process, with subkeys applied in reverse order:

1. Apply the initial permutation (IP) to the ciphertext.
2. Execute Round 1 using subkey K_2.
3. Swap the two halves.
4. Execute Round 2 using subkey K_1.
5. Apply the inverse initial permutation (IP^{-1}) to recover the original plaintext.

4**. Implementation**

Pseudo-code Overview:

```
function SDES_Encrypt(plaintext, key):
 K1, K2 = generateSubkeys(key)
 IP_text = initialPermutation(plaintext)
 (L, R) = split(IP_text)

 // Round 1 using subkey K1
 temp = fK(R, K1)
 L_new = L XOR temp
 // Swap halves for round 2
 (L, R) = (R, L_new)

 // Round 2 using subkey K2
 temp = fK(R, K2)
 L_final = L XOR temp
```

```
// Combine halves and apply inverse IP
preoutput = combine(L_final, R)
ciphertext = inverseInitialPermutation(preoutput)
return ciphertext
function fK(R, subkey):
expanded_R = expansionPermutation(R)
xor_result = expanded_R XOR subkey
(left_part, right_part) = split(xor_result)
s0_output = S0(left_part)
s1_output = S1(right_part)
combined = combine(s0_output, s1_output)
p4_output = permutationP4(combined)
return p4_output
```

Note: The decryption process follows the same steps as encryption, with the subkeys applied in reverse order (K_2 first, then K_1).

5. Test And Outcome

5.1 Test Case

A sample test case was executed with the following parameters:

- Key: 1 0 1 0 0 0 0 0 1 0
- Plaintext: 11010111

Step 1: We accepted a 10-bit key and permuted the bits by putting them in the P10 table.
Key = 1 0 1 0 0 0 0 0 1 0
(k1, k2, k3, k4, k5, k6, k7, k8, k9, k10) = (1, 0, 1, 0, 0, 0, 0, 0, 1, 0)
P10 Permutation is: P10(k1, k2, k3, k4, k5, k6, k7, k8, k9, k10) = (k3, k5, k2, k7, k4, k10, k1, k9, k8, k6)
After P10, we get 1 0 0 0 0 0 1 1 0 0

Step 2: We divide the key into 2 halves of 5-bit each.
l=1 0 0 0 0, r=0 1 1 0 0

Step 3: Now we apply one bit left-shift on each key.
l = 0 0 0 0 1, r = 1 1 0 0 0

Step 4: Combine both keys after step 3 and permute the bits by putting them in the P8 table. The output of the given table is the first key K1.
After LS-1 combined, we get 0 0 0 0 1 1 1 0 0 0
P8 permutation is: P8(k1, k2, k3, k4, k5, k6, k7, k8, k9, k10) = (k6, k3, k7, k4, k8, k5, k10, k9)
After P8, we get Key-1: 1 0 1 0 0 1 0 0

Step 5: The output obtained from step 3 i.e. 2 halves after one-bit left shift should again undergo the process of two-bit left shift.
Step 3 output - l = 0 0 0 0 1, r = 1 1 0 0 0
After two-bit shift - l = 0 0 1 0 0, r = 0 0 0 1 1

Step 6: Combine the 2 halves obtained from step 5 and permute them by putting them in the P8 table. The output of the given table is the second key K2.
After LS-2 combined = 0 0 1 0 0 0 0 0 1 1
P8 permutation is: P8(k1, k2, k3, k4, k5, k6, k7, k8, k9, k10) = (k6, k3, k7, k4, k8, k5, k10, k9)
After P8, we get Key-2: 0 1 0 0 0 0 1 1

Final Outcome:
Key-1 is: 1 0 1 0 0 1 0 0
Key-2 is: 0 1 0 0 0 0 1 1

The S-DES encryption algorithm produced a ciphertext which, when processed through the decryption routine (using the subkeys in reverse order), successfully recovered the original plaintext. This confirms the correctness and reversibility of the encryption/decryption process.

6. **Applications and Limitations**

Applications:

- Used in cryptographic education to understand DES principles.
- Serves as a basic model for more complex encryption schemes.

Limitations:

- Small key size (10-bit) makes it highly vulnerable to brute-force attacks.
- Not suitable for real-world encryption due to weak security.

7. Conclusion

This lab report provided a detailed case study of Simple DES (S-DES), demonstrating how basic cryptographic operations are integrated to form a functional block cipher. Through the implementation of key generation, encryption, and decryption processes, we confirmed that S-DES reliably recovers plaintext from ciphertext, emphasizing the reversibility inherent in the Feistel structure. Although S-DES is not suitable for modern security needs, its simplicity makes it an invaluable educational tool for understanding the principles of symmetric-key cryptography.

8**. References**

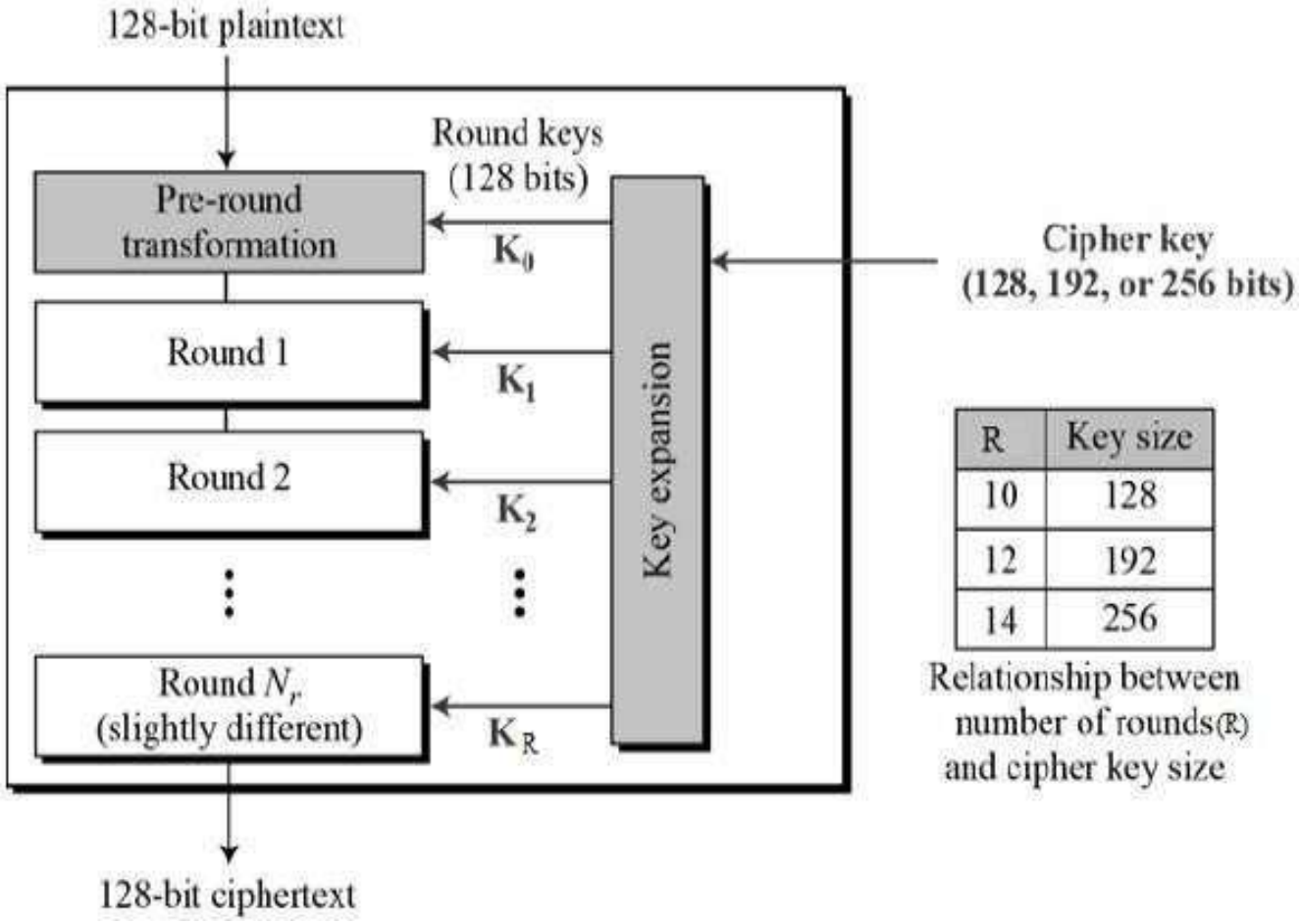
- Stallings, W. Cryptography and Network Security: Principles and Practice.
- Paar, C., & Pelzl, J. Understanding Cryptography: A Textbook for Students and Practitioners.
- Online resources and lecture notes on Simple DES (S-DES) implementations and tutorials.

Lab#7 Case study on: Simple AES prepare report.

Explanation:

The **Advanced Encryption Standard (AES)** is a **symmetric-key block cipher** adopted by the **U.S. National Institute of Standards and Technology (NIST)** in 2001 as a replacement for DES. It is based on the **Rijndael** algorithm and is widely used for secure data encryption.

Diagram:



R	Key size
10	128
12	192
14	256

Relationship between number of rounds(R) and cipher key size

Working:

AES operates on **fixed-size blocks of 128 bits** and supports key sizes of **128, 192, or 256 bits**. Unlike DES, AES does not use a Feistel structure but follows a **substitution-permutation network (SPN)** for encryption.

1. Key Expansion

- The input **key (128, 192, or 256 bits)** is expanded into multiple **round keys** using a process called the **Key Schedule**.
- The number of rounds depends on the key size:
  - o **10 rounds** for **128-bit key**
  - o **12 rounds** for **192-bit key**
  - o **14 rounds** for **256-bit key**

2. Initial Round

 The **plaintext (128-bit block)** undergoes an **AddRoundKey step**, where it is XORed with the first-round key.

3. Main Rounds (9, 11, or 13 rounds depending on key size)

Each round consists of the following steps:

1. **SubBytes (Byte Substitution)** o Each byte is replaced using a **Substitution Box (S-Box)**, adding confusion.
2. **ShiftRows** o Rows of the state matrix are **shifted cyclically** to the left, ensuring diffusion.
3. **MixColumns** o A mathematical transformation is applied to columns, further mixing the data.
4. **AddRoundKey** o The **current state** is XORed with a **round key** generated from the key schedule.

4. Final Round

The **final round** omits the **MixColumns step** and consists of:

- **SubBytes**
- **ShiftRows**
- **AddRound Key**

- The final **128-bit ciphertext** is generated.

Advantages of DES:

- **Highly Secure** – AES is resistant to known attacks like **brute-force, differential cryptanalysis, and linear cryptanalysis**.
- **Larger Key Size** – Supports **128, 192, and 256-bit** keys, making it far more secure than DES.
- **Efficient and Fast** – Performs well in both hardware and software implementations.
- **Wide Adoption** – Used in **banking, government, cloud security, and wireless encryption (WPA2, TLS, SSL, etc.)**.
- **Flexible and Scalable** – Works with different key lengths based on security requirements.

Disadvantages of DES:

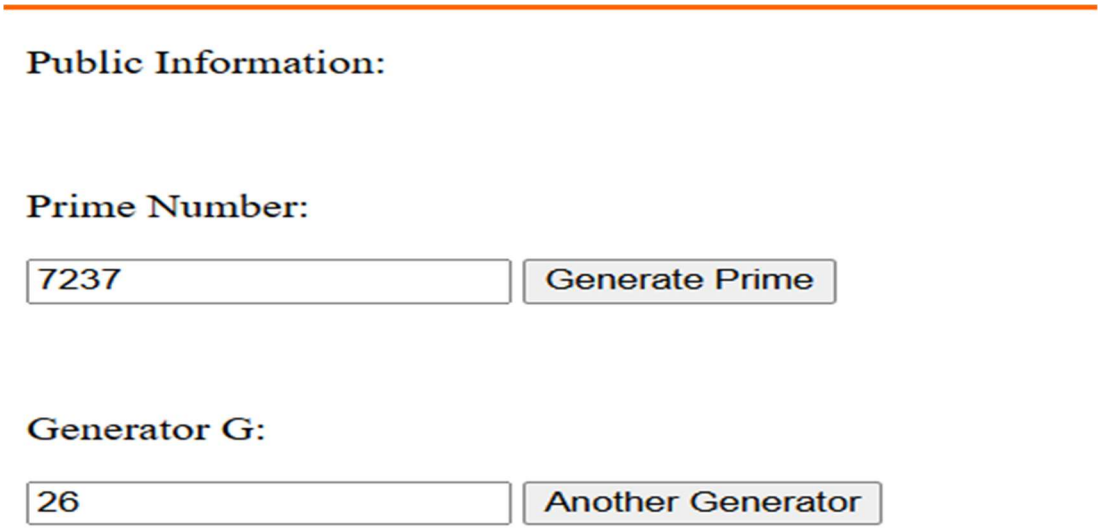
- **Computational Complexity** – More complex than DES, making it **slightly slower** in low-power devices.
- **Vulnerable to Side-Channel Attacks** – If implemented poorly, AES can be attacked using **power analysis or timing attacks**.
- **Key Management Overhead** – Secure storage and exchange of AES keys can be a challenge.

Practical 8: Implement Diffi-Hellmen Key exchange Method. Perform in PYTHON as well as in Virtual lab.

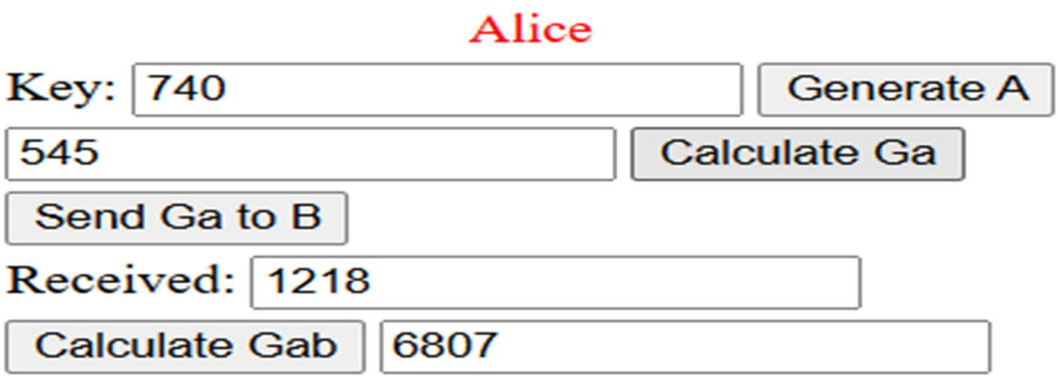
Link for Virtual Lab: - https://cse29-iiith.vlabs.ac.in/exp/diffie-hellman/simulation.html

Virtual Lab Simulator:

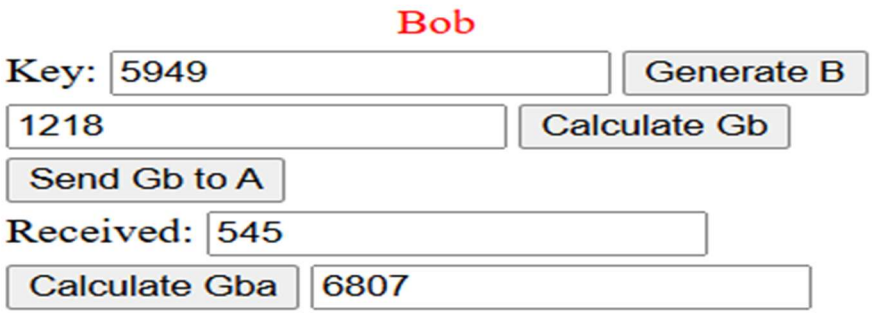
Step 1: Generate Prime.



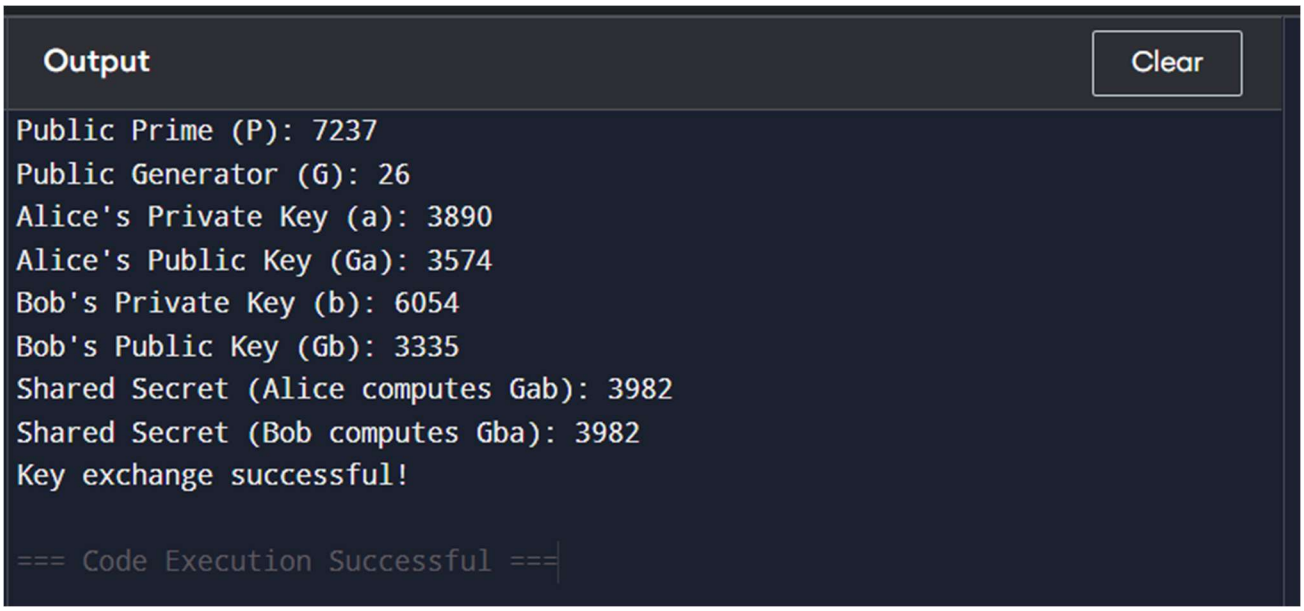
Step 2: Sender Side.



Step 3: Receiver Side



OUTPUT:



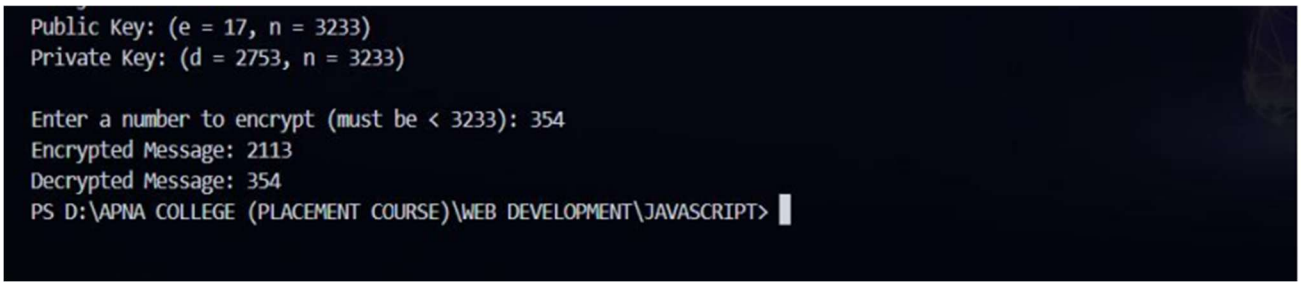
CODE:

```
import random

def mod_exp(base, exponent, mod):
    """Efficiently computes (base^exponent) % mod using modular
exponentiation."""
    result = 1
    base = base % mod  # Ensure base is within mod range
    while exponent > 0:
        if exponent % 2 == 1:
            result = (result * base) % mod
        exponent //= 2
        base = (base * base) % mod
    return result

# Public parameters (from the images)
P = 7237  # Prime number
G = 26    # Generator

# Alice's private key
a = random.randint(2, P-2)  # Randomly chosen private key
Ga = mod_exp(G, a, P)  # Compute public key

# Bob's private key
b = random.randint(2, P-2)  # Randomly chosen private key
Gb = mod_exp(G, b, P)  # Compute public key

# Exchange Ga and Gb (simulated here)
received_by_bob = Ga
received_by_alice = Gb

# Compute shared secret
shared_secret_alice = mod_exp(received_by_alice, a, P)
shared_secret_bob = mod_exp(received_by_bob, b, P)

# Output results
print("Public Prime (P):", P)
print("Public Generator (G):", G)
print("Alice's Private Key (a):", a)
print("Alice's Public Key (Ga):", Ga)
print("Bob's Private Key (b):", b)
print("Bob's Public Key (Gb):", Gb)
print("Shared Secret (Alice computes Gab):", shared_secret_alice)
print("Shared Secret (Bob computes Gba):", shared_secret_bob)
```

```
# Verify both shared secrets are equal
if shared_secret_alice == shared_secret_bob:
    print("Key exchange successful!")
else:
    print("Error: Shared secrets do not match!")
```

Practical 9: Implement RSA encryption-decryption algorithm.

OUTPUT:



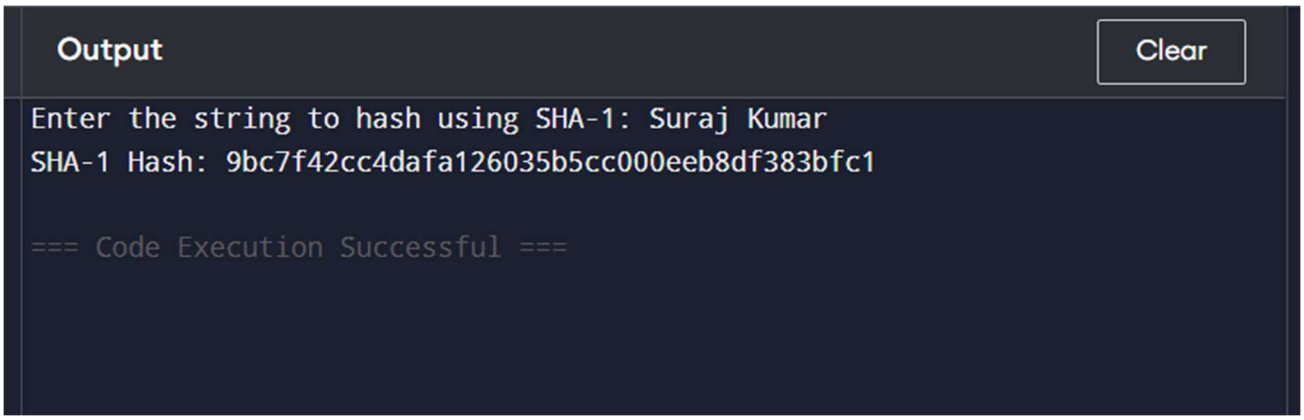
CODE:

```
import math

def gcd(a, b):
    while b != 0:
        a, b = b, a % b
    return a

def mod_inverse(e, phi):
    t, new_t = 0, 1
    r, new_r = phi, e

    while new_r != 0:
        quotient = r // new_r
        t, new_t = new_t, t - quotient * new_t
        r, new_r = new_r, r - quotient * new_r

    if r > 1:
        return -1  # No modular inverse exists
    if t < 0:
        t += phi

    return t

def mod_exp(base, exp, mod):
    result = 1
    base = base % mod

    while exp > 0:
        if exp % 2 == 1:
```

```
            result = (result * base) % mod
        exp = exp >> 1
        base = (base * base) % mod

    return result

def main():
    # Two prime numbers (for real implementation, use large primes)
    p, q = 61, 53
    n = p * q
    phi = (p - 1) * (q - 1)

    e = 17
    while gcd(e, phi) != 1:
        e += 1

    d = mod_inverse(e, phi)

    print(f"Public Key: (e = {e}, n = {n})")
    print(f"Private Key: (d = {d}, n = {n})\n")

    message = int(input(f"Enter a number to encrypt (must be < {n}): "))

    if message >= n:
        print(f"Message must be smaller than {n}")
        return

    encrypted = mod_exp(message, e, n)
    print(f"Encrypted Message: {encrypted}")

    decrypted = mod_exp(encrypted, d, n)
    print(f"Decrypted Message: {decrypted}")

if __name__ == "__main__":
    main()miz.pro")
```

Practical 10: Write a program to generate SHA-1 hash.

OUTPUT:



CODE:

```
import hashlib

# Take input from the user
user_input = input("Enter the string to hash using SHA-1: ")

# Encode the input string
encoded_input = user_input.encode()

# Generate SHA-1 hash
sha1_hash = hashlib.sha1(encoded_input).hexdigest()

# Print the resulting hash
print("SHA-1 Hash:", sha1_hash)
```

Practical 11: Implement a digital signature algorithm.

OUTPUT:

```
mathematica                                                    Copy    Edit

Enter message to sign: Suraj
SHA-1 Hash (hex): 3c29b8b7eae26c7e0c7c742d3fa4f85fca9c6f70

🔏 Digital Signature (hex): 8b11fcb0b7...

✅ Signature is valid.
```

CODE:

Note: First, install the required library (if not already installed): (pip install cryptography).

```
from cryptography.hazmat.primitives.asymmetric import rsa, padding
from cryptography.hazmat.primitives import hashes
import binascii

# Step 1: Generate RSA key pair
private_key = rsa.generate_private_key(public_exponent=65537,
key_size=2048)
public_key = private_key.public_key()

# Step 2: Get input message from user
message = input("Enter message to sign: ").encode('utf-8')

# Step 3: Hash the message using SHA-1
digest = hashes.Hash(hashes.SHA1())
digest.update(message)
hash_bytes = digest.finalize()
print("SHA-1 Hash (hex):", binascii.hexlify(hash_bytes).decode())

# Step 4: Sign the hash
signature = private_key.sign(
    hash_bytes,
    padding.PSS(
        mgf=padding.MGF1(hashes.SHA1()),
```

```
        salt_length=padding.PSS.MAX_LENGTH
    ),
    hashes.SHA1()
)

# Show signature in hex format
signature_hex = binascii.hexlify(signature).decode()
print("\n🔏 Digital Signature (hex):", signature_hex)

# Step 5: Verify the signature
try:
    public_key.verify(
        signature,
        hash_bytes,
        padding.PSS(
            mgf=padding.MGF1(hashes.SHA1()),
            salt_length=padding.PSS.MAX_LENGTH
        ),
        hashes.SHA1()
    )
    print("✅ Signature is valid.")
except Exception as e:
    print("❌ Signature verification failed.")
```

Lab#12 Study and use the Wireshark for the various network protocols.

1. Introduction to Wireshark

Wireshark is one of the most powerful and widely-used network protocol analyzers. It is open-source and allows users to capture and interactively browse the traffic running on a computer network. Originally named **Ethereal**, it was later renamed Wireshark in 2006 due to trademark issues.

Wireshark helps network administrators, cybersecurity experts, and developers analyze and troubleshoot network-related issues, security breaches, and performance bottlenecks.

2. Key Features of Wireshark

Wireshark comes with a rich set of features that make it the go-to tool for network analysis:

1. Live Packet Capture + Offline Analysis

Capture real-time traffic from interfaces like Ethernet, Wi-Fi, USB, loopback, etc. Save captures in .pcap/.pcapng formats for offline analysis—ideal for forensics, debugging, and reporting.

Use Cases:

- Diagnose slow network or dropped connections
- Monitor suspicious or malicious activity
- Review historical network traffic

2. Deep Protocol Inspection

Wireshark supports deep analysis of 1000+ protocols: TCP/IP, HTTP, DNS, ARP, ICMP, DHCP, FTP, TLS, and more.

How It Works:

- Dissects each packet across layers (L2 to L7)
- Shows field names, values, interpretations
- Highlights anomalies or malformed packets

3. Advanced Display & Capture Filters Filter specific traffic using powerful expressions.

Examples:

- http → Only HTTP packets
- ip.addr == 192.168.1.1 → Traffic from/to an IP
- tcp.port == 443 → HTTPS traffic
- frame contains "password" → Find unencrypted credentials

Auto-suggestions, syntax validation, and logical operators (and, or, not)

4. *Color Coding for Fast Identification*

Default and custom rules make key traffic stand out.

Color Examples:

- Light purple → TCP
- Light blue → DNS
- Black/Red → Malformed/dropped packets

Quickly identify retransmissions, unauthorized traffic, or errors.

5. *Three-Pane Interface for Packet Analysis*

- **Packet List:** Timestamp, source, destination, protocol, length, info
- **Packet Details:** Protocol breakdown (Ethernet > IP > TCP > HTTP)
- **Packet Bytes:** Raw data in hex + ASCII Enables forensic-style deep inspection.

6. *Export & Share Data*

Export captured traffic in multiple formats:

- .pcap/.pcapng → Standard format
- .csv, .json, .xml, .txt → Reports, logs, automation

Share with security teams, use for documentation or analysis scripts.

7. *Decryption Support (SSL/TLS, WPA2, etc.)*

Analyze encrypted traffic if you have access to keys or credentials.

Supported Protocols:

- SSL/TLS (via SSLKEYLOGFILE or private key)
- WPA/WPA2 (with passphrase)
- IPsec, SNMPv3, Kerberos

Decryption only works if keys or credentials are available.

8. Packet Reassembly

Reconstruct large data split across multiple packets.

Examples:

- Full HTTP responses
- FTP file transfers
- Chat sessions over IRC

3

9. VoIP & RTP Analysis

Decode and analyze SIP/RTP voice traffic.

Features:

- Listen to RTP streams
- View call quality (jitter, loss, delay)
- Troubleshoot VoIP issues in real-time

10. Custom Profiles & Layouts

Create task-specific profiles to streamline your workflow.

Why Use It?

- Custom column views
- Saved filters
- Switch contexts quickly (e.g., web, DNS, security)

11. Multi-Platform Support

Wireshark works on Windows, macOS, and Linux with consistent UI and feature sets.

12. Command-Line Version – tshark

Wireshark includes tshark for terminal-based traffic capture and analysis.

Use Cases:

- Automation scripts
- Cron jobs
- Headless server environments

13. Integration with Other Tools Works well with tools like:

- **Nmap** → Network scanning
- **Snort/Suricata** → IDS alerts
- **Metasploit** → Attack monitoring
- **Tcpdump** → Initial captures for later Wireshark analysis

3. Key Features of Wireshark

For Windows:

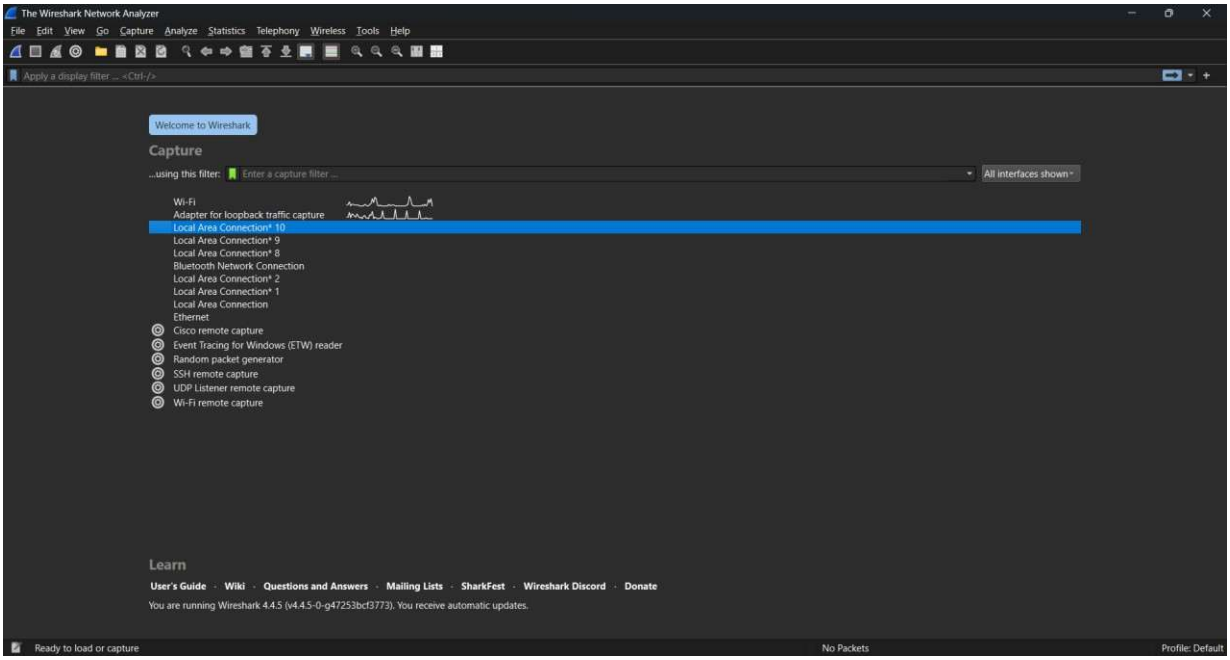
1. Download Wireshark from the official site: https://www.wireshark.org
2. Follow the installation wizard.
3. Make sure to install WinPcap or Npcap (required for packet capturing).

4. Basic Terminologies in Wireshark

- Packet: A unit of data sent across a network.
- Capture Filter: Used before starting the capture to limit what data gets collected.
- Display Filter: Used after capturing data to filter the view.
- Protocols: Define rules for data exchange (e.g., HTTP, TCP, DNS, ARP).

5. Using Wireshark *Step 1: Starting a Capture*

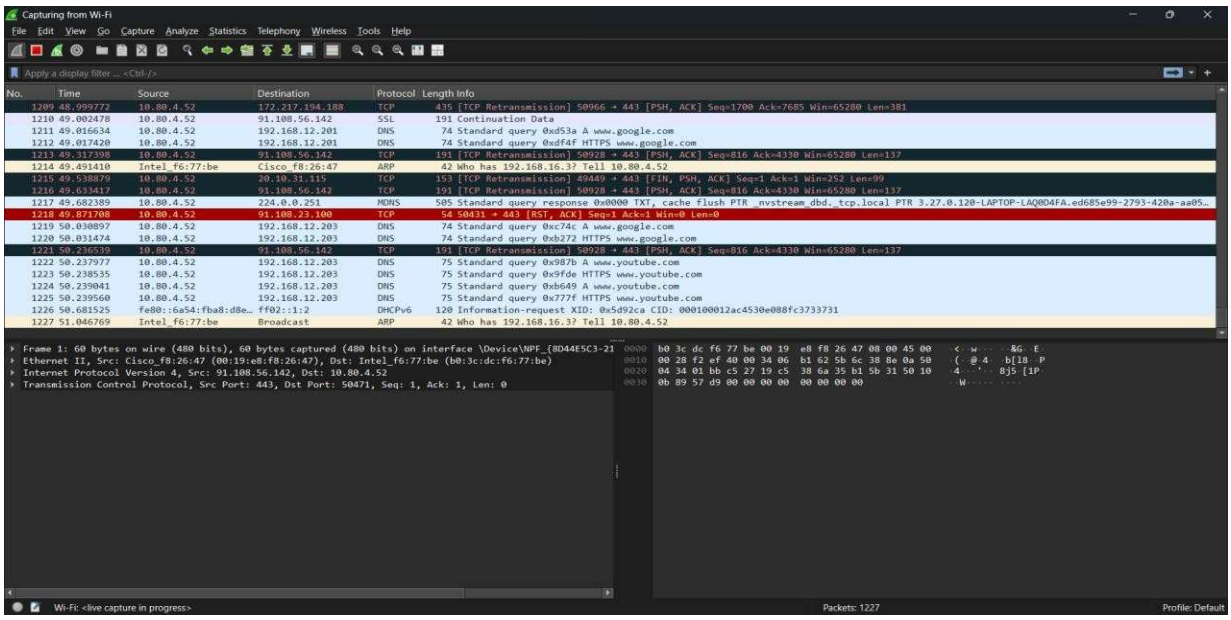
- Open Wireshark.
- Select the appropriate network interface (e.g., Wi-Fi, Ethernet).
- Click **Start Capturing Packets**.



Step 2: Applying Filters

Wireshark provides both **capture** and **display** filters. Examples:

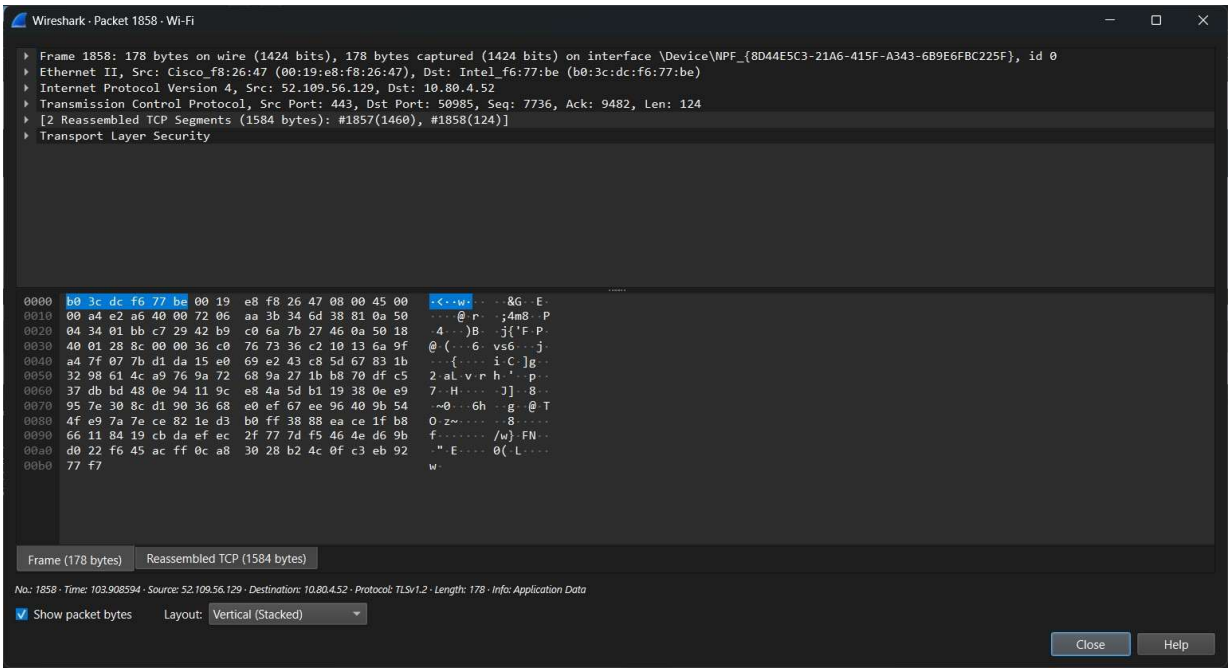
- `http` → Show only HTTP traffic
- `ip.addr == 192.168.1.1` → Show packets to/from that IP
- `tcp.port == 443` → Show only HTTPS packets



Step 3: Analyzing Packets

Clicking on a packet reveals detailed information in the lower panes:

- Frame details
- Ethernet header
- IP Header
- TCP/UDP information
- Application layer details



6. Real-World Use Cases of Wireshark

- Network troubleshooting: Identify dropped packets, latency issues, or misconfigured devices.
- Security analysis: Detect malware, ARP spoofing, and intrusion attempts.
- Protocol development: Validate and debug network-related code.
- Learning and teaching tool: Perfect for students learning networking.