Cryptography And Network Security Lab

Assignment submission

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Batch: B5

Assignment: 7

Title of assignment: Implementation of AES – Advanced Encryption Standard

Title:

Implementation of Advanced Encryption Standard

Aim:

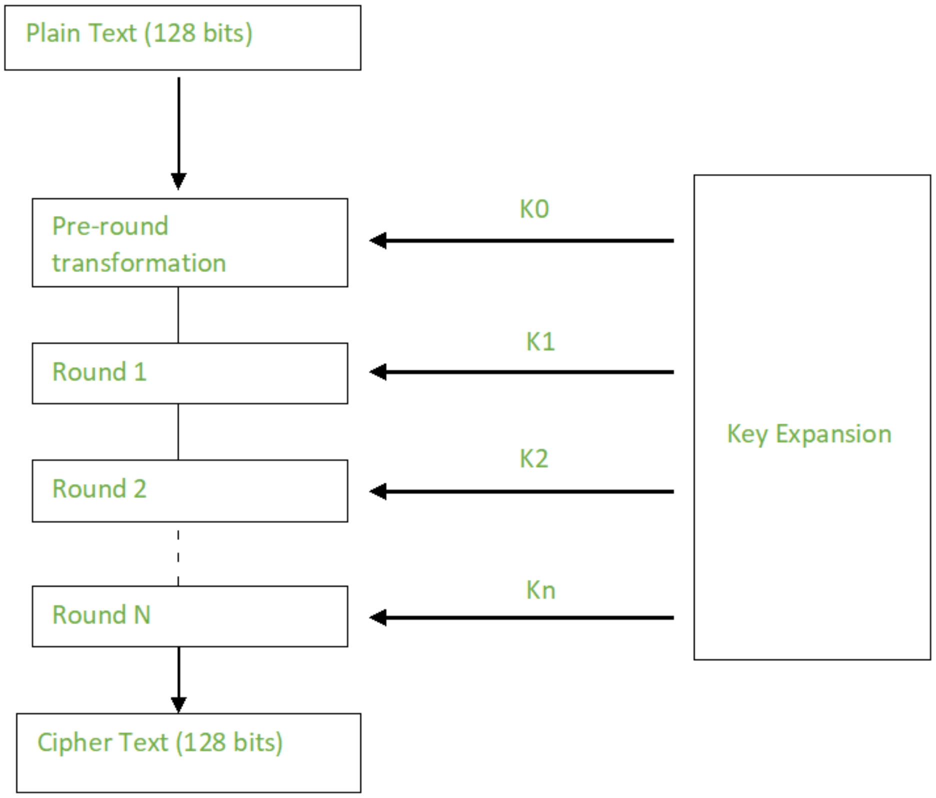
To develop and implement the Advanced Encryption Standard and to do encryption and decryption on the input plaintext

Theory:

- AES is an iterative rather than Feistel cipher. It is based on 'substitution–permutation network'.
- Comprises of a series of linked operations, some of which involve replacing inputs by specific outputs (substitutions) and others involve shuffling bits around (permutations).
- AES performs all its computations on bytes rather than bits. Hence, AES treats the 128 bits of a plaintext block as 16 bytes. These 16 bytes are arranged in four columns and four rows for processing as a matrix

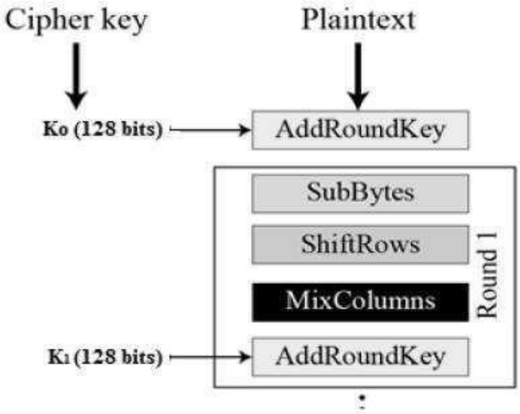
- the number of rounds in AES is variable and depends on the length of the key.
- AES uses 10 rounds for 128-bit keys, 12 rounds for 192-bit keys and 14 rounds for 256-bit keys. Each of these rounds uses a different 128-bit round key

- The features of AES are as follows
  - Symmetric key symmetric block cipher
  - 128-bit data, 128/192/256-bit keys
  - Stronger and faster than Triple-DES
  - Provide full specification and design details
  - Software implementable in C and Java



Encryption:

A typical round of AES encryption comprises of four sub-processes. The first round process is depicted below –



Byte Substitution (SubBytes)

The 16 input bytes are substituted by looking up a fixed table (S-box) given in design. The result is in a matrix of four rows and four columns.

Shiftrows

Each of the four rows of the matrix is shifted to the left. Any entries that ‘fall off’ are re-inserted on the right side of row. Shift is carried out as follows −

1. First row is not shifted.
2. Second row is shifted one (byte) position to the left.
3. Third row is shifted two positions to the left.
4. Fourth row is shifted three positions to the left.

The result is a new matrix consisting of the same 16 bytes but shifted with respect to each other.

MixColumns

Each column of four bytes is now transformed using a special mathematical function. This function takes as input the four bytes of one column and outputs four completely new bytes, which replace the original column. The result is another new matrix consisting of 16 new bytes.

This step is not performed in the last round.

Addroundkey

The 16 bytes of the matrix are now considered as 128 bits and are XORed to the 128 bits of the round key. If this is the last round then the output is the ciphertext. Otherwise, the resulting 128 bits are interpreted as 16 bytes and we begin another similar round.

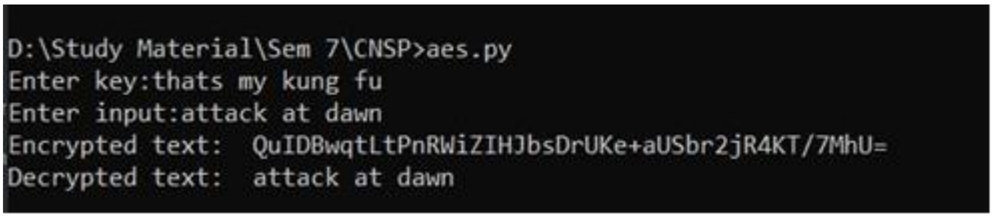
Implementation of Advanced Encryption Standard

Code:

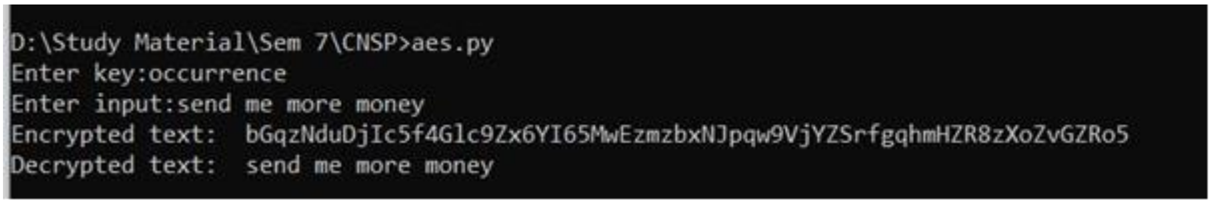
```
import hashlib
from Crypto import Random
from Crypto.Cipher import AES
from base64 import b64encode, b64decode

class AESCipher(object):
    def __init__(self, key):
        self.block_size = AES.block_size
        self.key = hashlib.sha256(key.encode()).digest()

    def encrypt(self, plain_text):
        plain_text = self.__pad(plain_text)
        iv = Random.new().read(self.block_size)
        cipher = AES.new(self.key, AES.MODE_CBC, iv)
        encrypted_text = cipher.encrypt(plain_text.encode())
        return b64encode(iv, encrypted_text).decode("ütf-8")

    def decrypt(self, encrypted_text):
        encrypted_text = b64decode(encrypted_text)
        iv = encrypted_text[:self.block_size]
        cipher = AES.new(self.key , AES.MODE.CBC, iv)
        plain_text =
cipher.decrypt(encrypted_text[self.block_size:]).decode("utf-8")
        return self.__unpad(plain_text)

    def __pad(self, plain_text):
        number_of_bytes_to_pad = self.block_size - len(plain_text) %
self.block_size
        ascii_string = chr(number_of_bytes_to_pad)
        padding_sgtr = number_of_bytes_to_pad * ascii_string
```

```
                padded_plain_text = plain_text + padding_str
                return padded_plain_text

        @staticmethod
        def __unpad(plain_text):
                last_character = plain_text[len(plain_text) - 1:]
                return plain_text[:ord(last_character)]

key = input("Enter Key:")
obj = AESCipher(key)
str = input("Enter input: ")
cipher = obj.encrypt(str)
print(cipher)
plain_text = obj.decrypt(cipher)
print(plain_text)
```

Output:

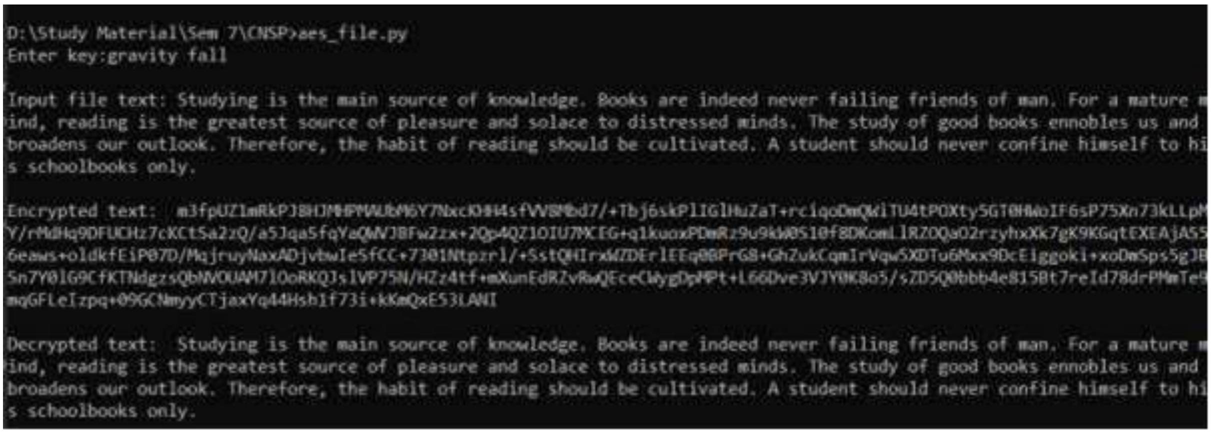


```
D:\Study Material\Sem 7\CNSP>aes.py
Enter key:thats my kung fu
Enter input:attack at dawn
Encrypted text:  QuIDBwqtLtPnRWiZIHJbsDrUKe+aUSbr2jR4KT/7MhU=
Decrypted text:  attack at dawn
```



```
D:\Study Material\Sem 7\CNSP>aes.py
Enter key:occurrence
Enter input:send me more money
Encrypted text:  bGqzNduDjIc5f4Glc9Zx6YI65MwEzmzbxNJpqw9VjYZSrfgqhmHZR8zXoZvGZRo5
Decrypted text:  send me more money
```

File Input:



```
D:\Study Material\Sem 7\CNSP>aes_file.py
Enter key:gravity fall

Input file text: Studying is the main source of knowledge. Books are indeed never failing friends of man. For a mature m
ind, reading is the greatest source of pleasure and solace to distressed minds. The study of good books ennobles us and
broadens our outlook. Therefore, the habit of reading should be cultivated. A student should never confine himself to hi
s schoolbooks only.

Encrypted text:  m3fpUZ1mRkPJ8HJMHPMAUbM6Y7NxcKHH4sfVVBMbd7/+Tbj6skPlIGlHuZaT+rciqoDmQWlTU4tPOXty5GT0HWoIF6sP75Xn73kLLpM
Y/rMdHq9DFUCHz7cKCtSa2zQ/a5Jqa5fqYaQWVJBFw2zx+2Qp4QZ1OIU7MCEG+q1kuoxPDmRz9u9kW0S10f8DKomL1RZOQaO2rzyhxXk7gK9KGqtEXEAjAS5
6eaws+oldkfEiP07D/MqjruyNaxADjvbwIe5fCC+7301Ntpzrl/+SstQHIrxWZDErlEEq0BPrG8+GhZukCqmIrVqw5XDTu6Mxx9DcEiggoki+xoDmSps5gJB
5n7Y0lG9CfKTNdgzsQbNVOUAM7lOoRKQJslVP75N/HZz4tf+mXunEdRZvRwQEceCWygDpMPt+L66Dve3VJY0K8o5/sZD5Q0bbb4e815Bt7reId78drPMmTe9
mqGFLeIzpq+09GCNmyyCTjaxYq44Hsb1f73i+kKmQxE53LANI

Decrypted text:  Studying is the main source of knowledge. Books are indeed never failing friends of man. For a mature m
ind, reading is the greatest source of pleasure and solace to distressed minds. The study of good books ennobles us and
broadens our outlook. Therefore, the habit of reading should be cultivated. A student should never confine himself to hi
s schoolbooks only.
```

Conclusion:

Performed the experiment successfully. Encrypted the data with the provided key. Output of this encryption is decrypted to match the plaintext that was inputted by the user as shown in the above diagram.