
# LAB REPORT

## *SWE430: Information and Network Security*

### Submitted to

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# LAB 3
# Symmetric encryption & hashing

## TASK 3.1: AES encryption using different modes

Firstly, I openned a text file names **task1.txt**
Then I gave the following commands:

**Using AES128 CBC**

openssl enc -aes-128-cbc -e -in task1.txt -out task1aes128cbc.bin
-K 7794212354564627485 6abcbdcedaeab
-iv 33355500033347349994444453555222

openssl enc -aes-128-cbc -d -in task1aes128cbc.bin
-out task1aes128cbcdecrypted.txt
-K 779421235456462748 56abcbdcedaeab -iv
33355500033347349994444453555222

**Using AES128 CFB**

openssl enc -aes-128-cfb -e -in task1.txt -out task1aes128cfb.bin
-K 7794212354564627485 6abcbdcedaeab
-iv 33355500033347349994444453555222

openssl enc -aes-128-cfb -d -in task1aes128cfb.bin
-out task1aes128cfbdycrypted.txt
-K 7794212354564627485 6abcbdcedaeab
-iv 33355500033347349994444453555222

**Using AES128 ECB**

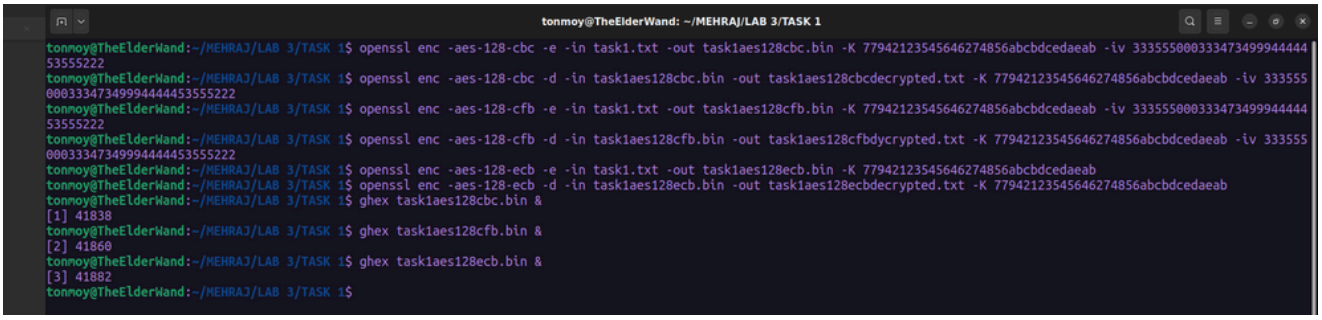
openssl enc -aes-128-ecb -e -in task1.txt -out task1aes128ecb.bin
-K 7794212354564627485 6abcbdcedaeab

openssl enc -aes-128-ecb -d -in task1aes128ecb.bin
-out task1aes128ecbdecrypted.txt
-K 7794212354564627485 6abcbdcedaeab

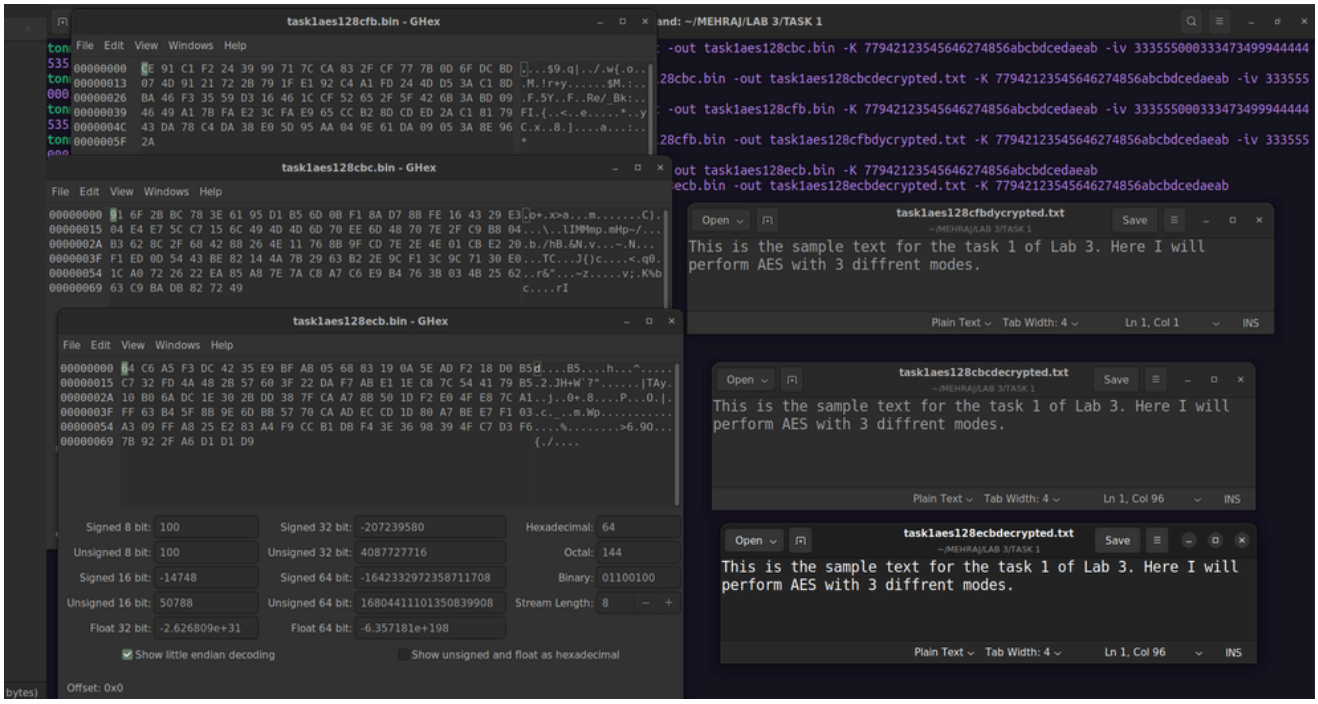
**To read the encrypted binary files I used ghex:**

ghex task1aes128cbc.bin &
ghex task1aes128cfb.bin &
ghex task1aes128ecb.bin &

These are the commands that I gave




This are the encrypted and decrypted files

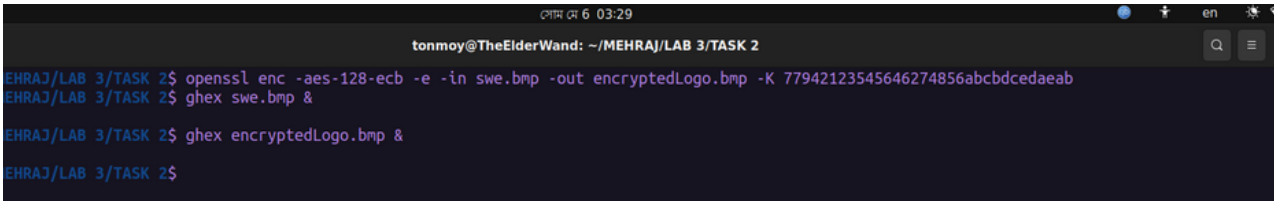



# TASK 3.2: ENCRYPTION MODE - ECB VS CBC

I downloaded the logo of SWE Society and converted it to bmp file.
The name of the file is swe.bmp

## ENCRYPT USING AES128-ECB

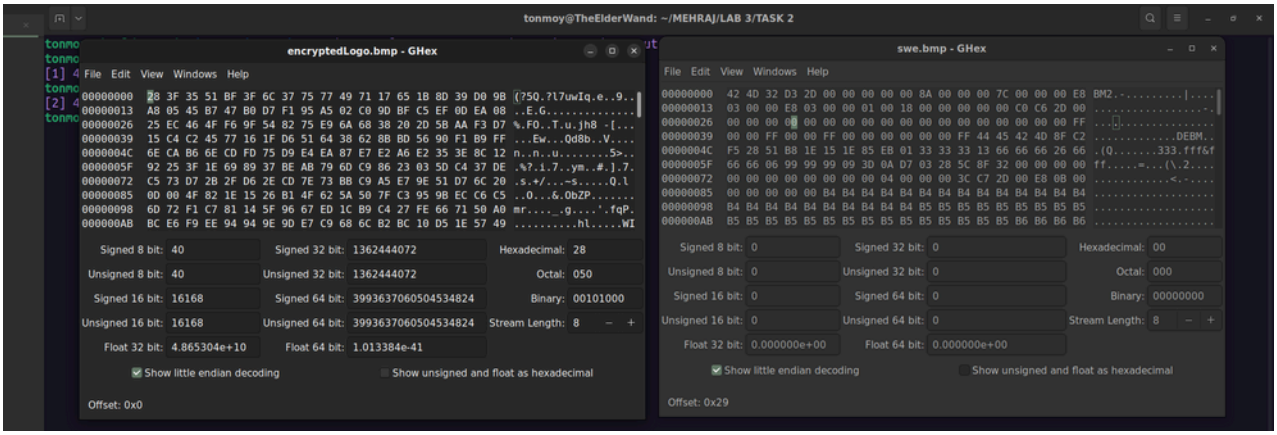
openssl enc -aes-128-ecb -e -in swe.bmp  -out encryptedLogo.bmp
-K 77942123545646274856abcbdcedaeab
ghex swe.bmp &

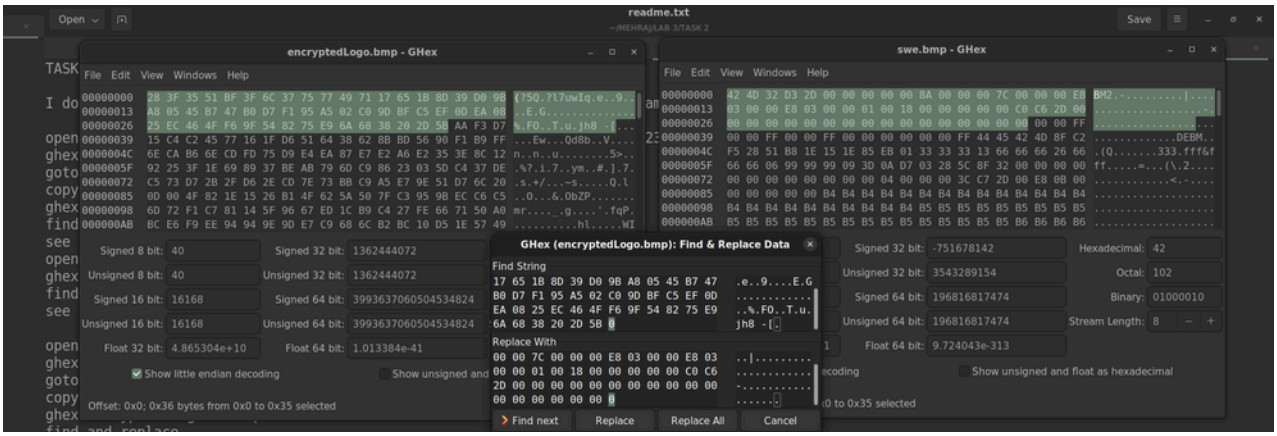


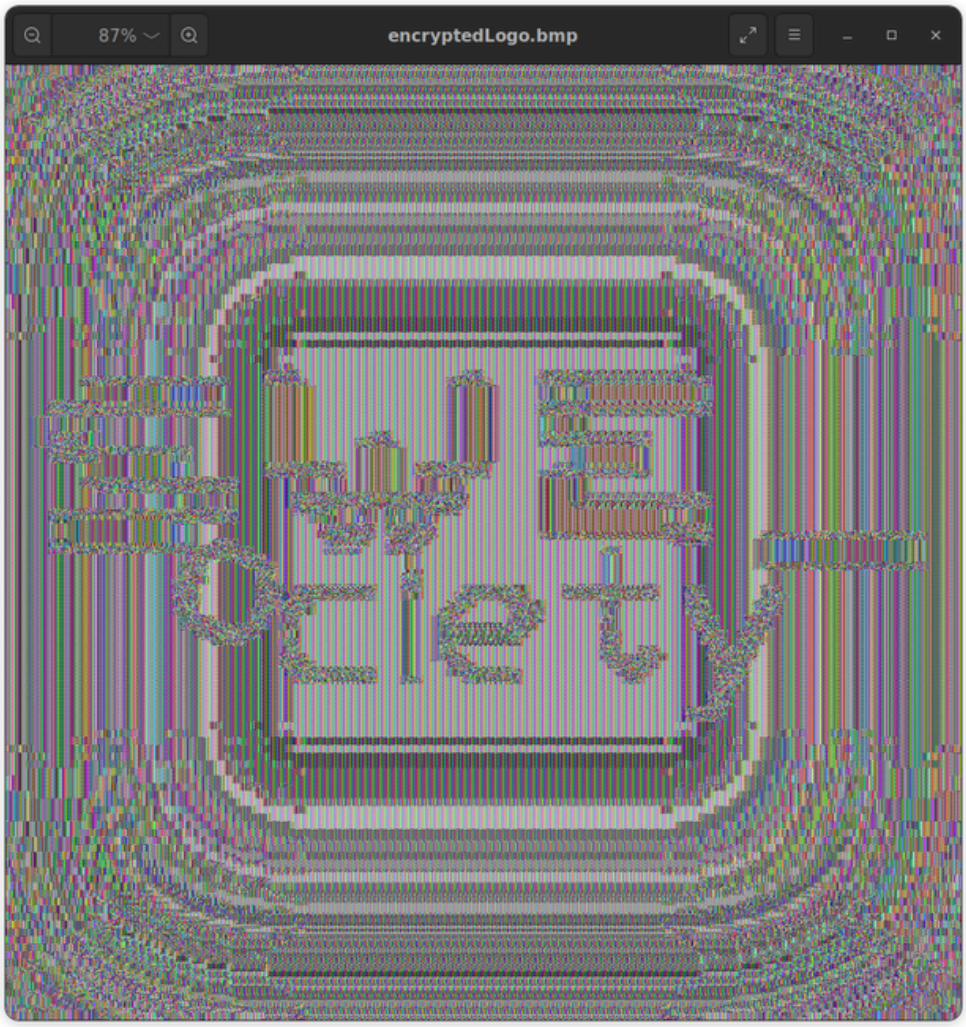

Now the encrypted image cannot be read due to the header encryption so now I will take the first 52 bits  from swe.bmp and replace those bits in the encrypted image

## PROCEDURE:

goto byte 54 of swe.bmp
copy 54 bits
ghex encryptedLogo.bmp &
goto byte 54
find and replace



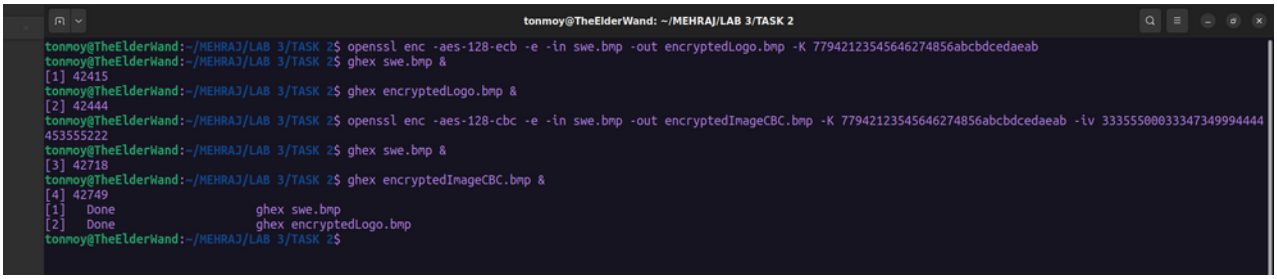



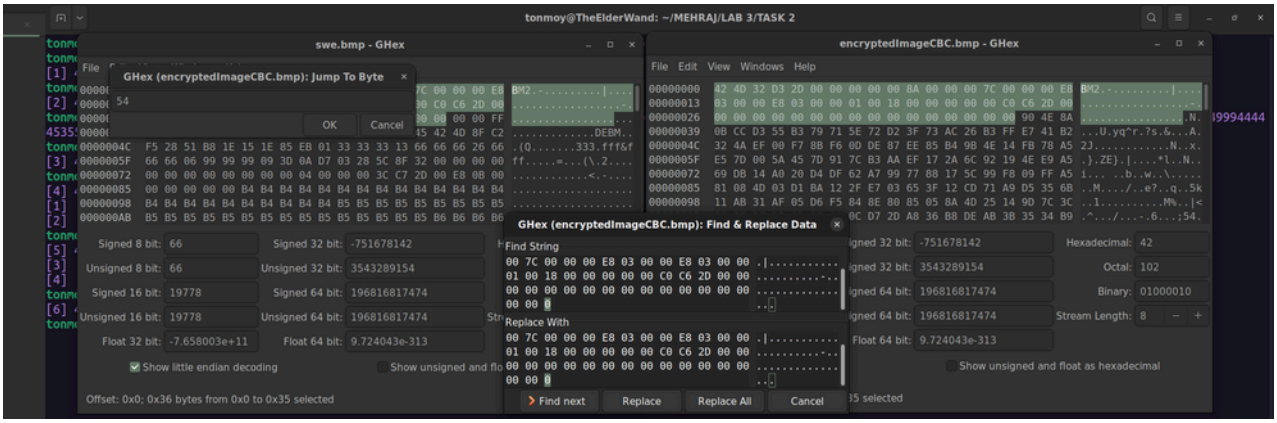


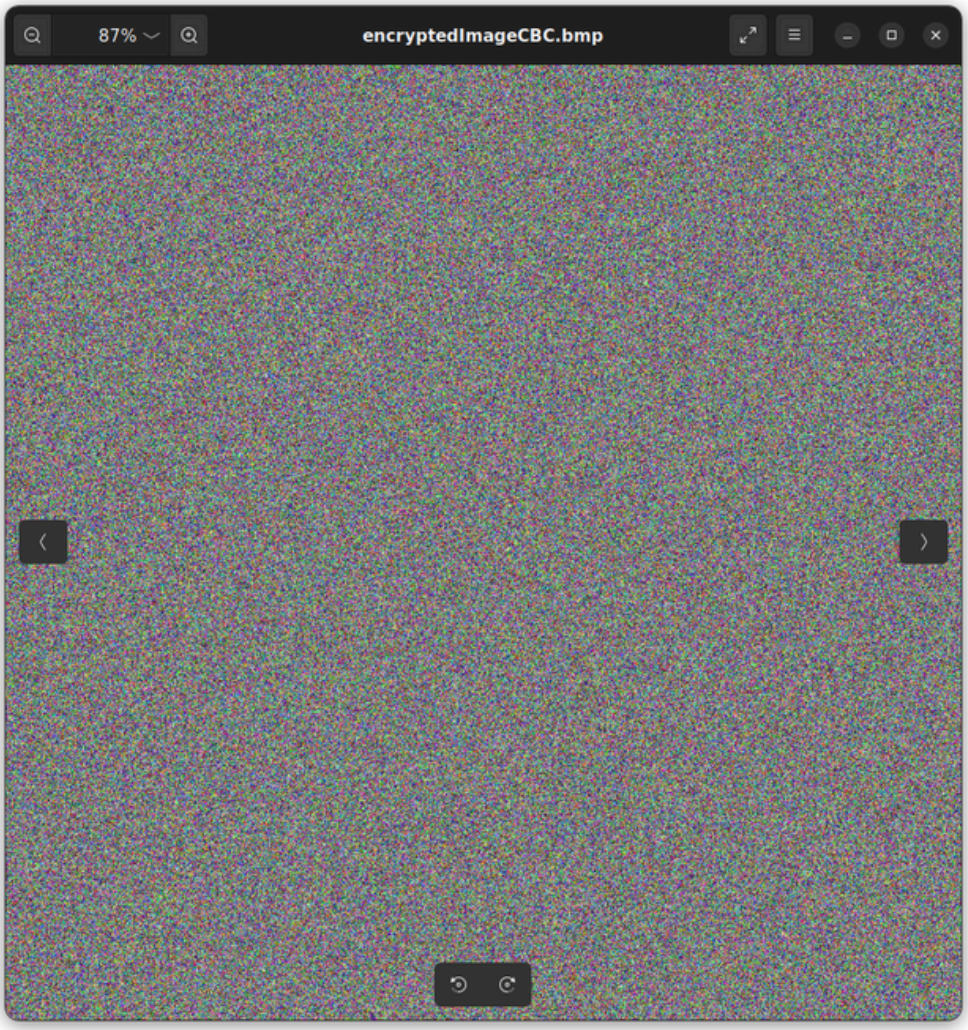

This is the output of the encryption for AES128-ECB

**USING AES128-CBC**

openssl enc -aes-128-cbc -e -in swe.bmp -out encryptedImageCBC.bmp
-K 7794212354564627 4856abcbdcedaeab
-iv 33355500033347349994444453555222
ghex swe.bmp &





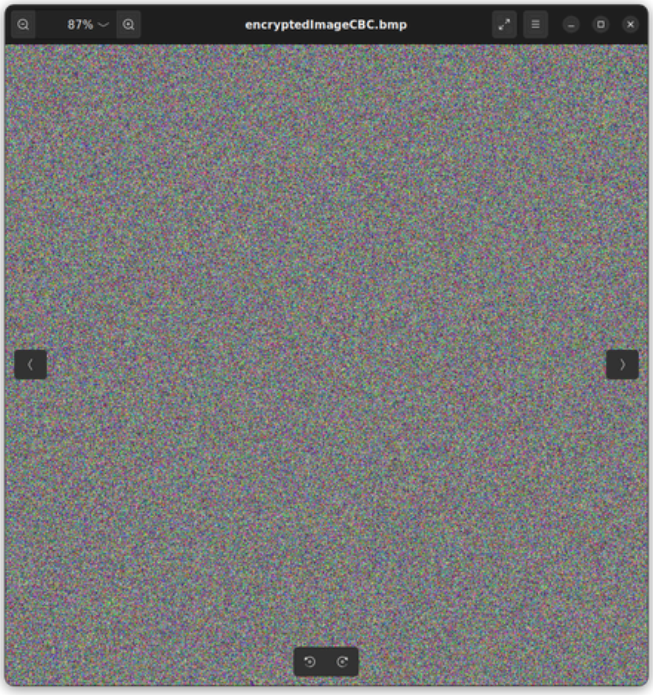

This is the output of the encryption for AES128-CBC

## ECB & CBC Mode Analysis

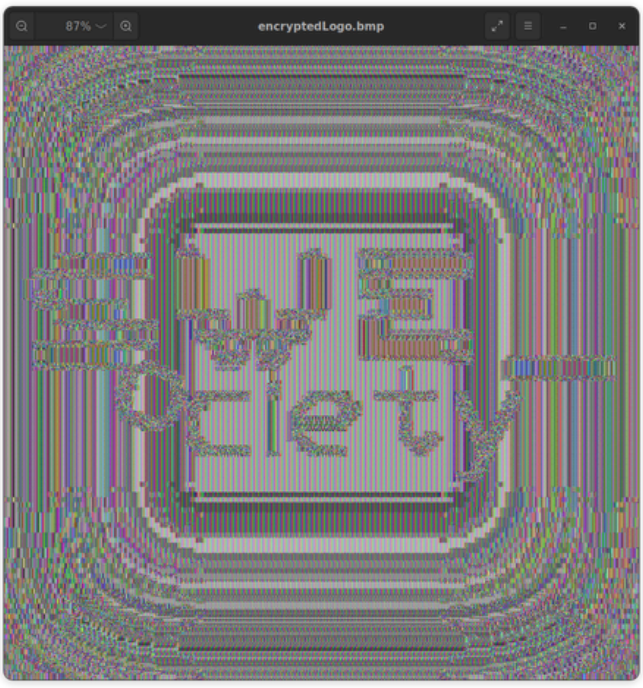
CBC (Cipher Block Chaining) and ECB (Electronic Codebook) are both block cipher encryption. where each block of plaintext is encrypted independently with the same key in ECB mode.  It lacks diffusion, meaning identical blocks of plaintext will result in identical blocks of ciphertext. This can lead to security vulnerabilities, especially in image encryption, where patterns might be preserved. On the other hand, In CBC mode, each plaintext block is XORed with the previous ciphertext block before encryption. This adds diffusion, making it more resistant to patterns and repetition in the plaintext. CBC mode requires an Initialization Vector (IV) for the first block to start the chaining process.

### COMPAISON:

ECB is simpler and faster, but less secure, especially for images. CBC is more secure due to its chaining mechanism, but slightly slower and requires an IV. For image encryption, CBC is generally preferred over ECB due to its better resistance to pattern preservation and higher security.



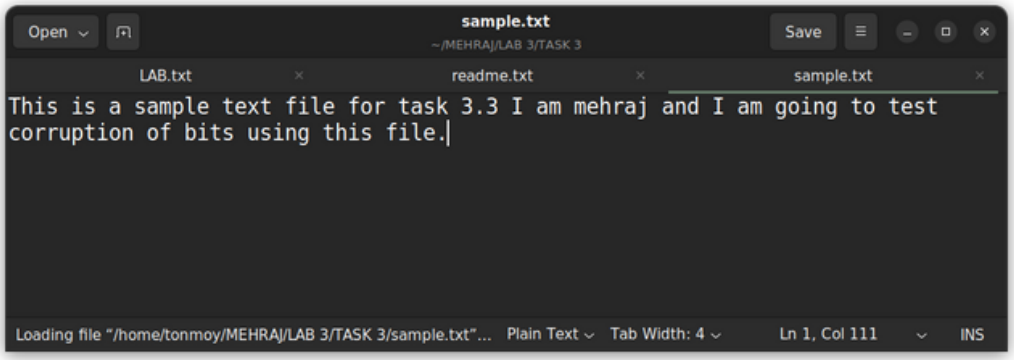

CBC




ECB

# TASK 3.3: ECRIPTION MODE : CORRUPTED CYPHERTEXT

Firstly, I created a text file sample.txt

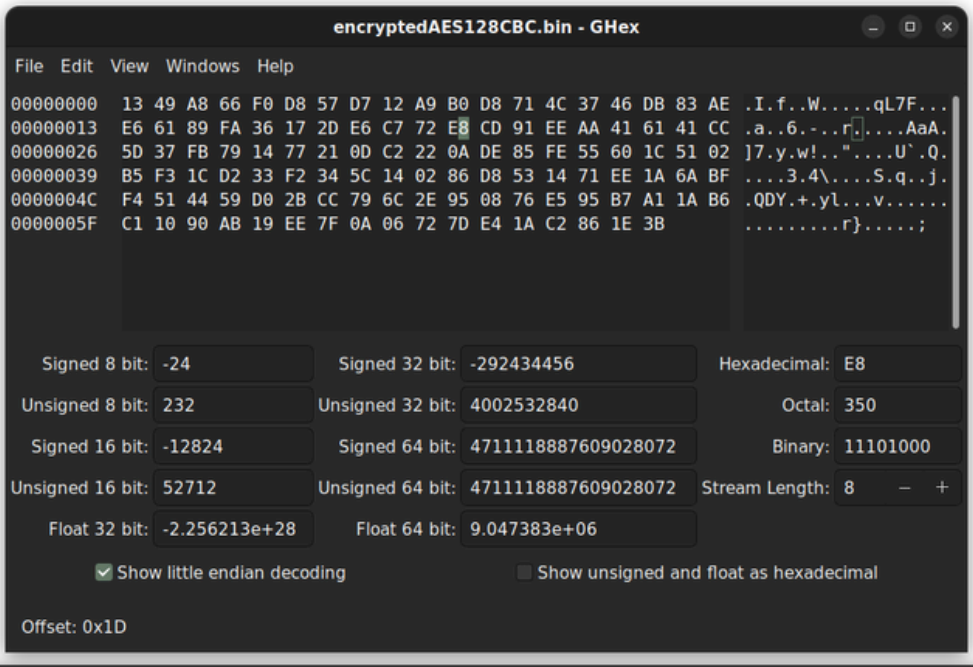


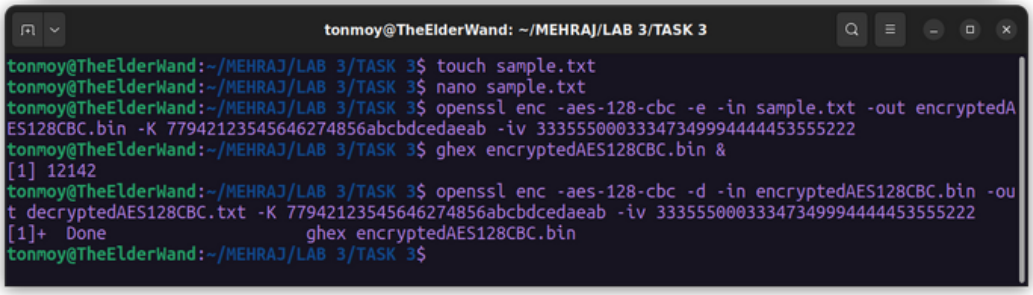

**FOR CBC MODE:**

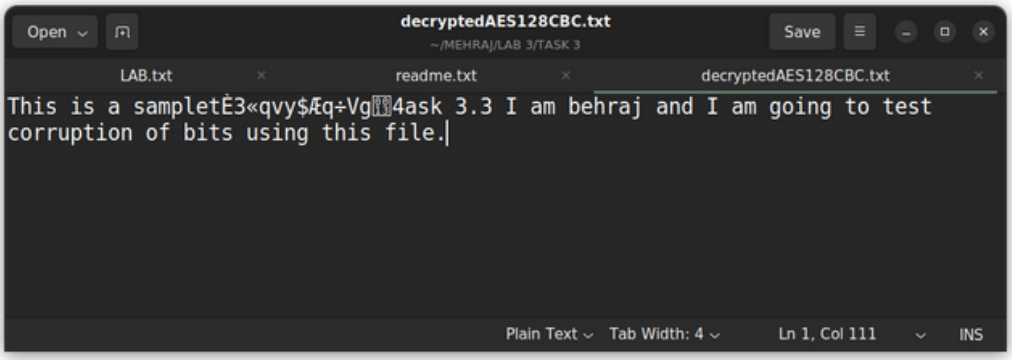
openssl enc -aes-128-cbc -e -in sample.txt -out encryptedAES128CBC.bin -K 7794212354564627485 6abcbdcedaeab -iv 33355500033347349994444453555222 ghex encryptedAES128CBC.bin &

Then I went to 30th bit and changed the HEX value

openssl enc -aes-128-cbc -d -in encryptedAES128CBC.bin -out decryptedAES128CBC.txt -K 7794212354564627485 6abcbdcedaeab -iv 33355500033347349994444453555222



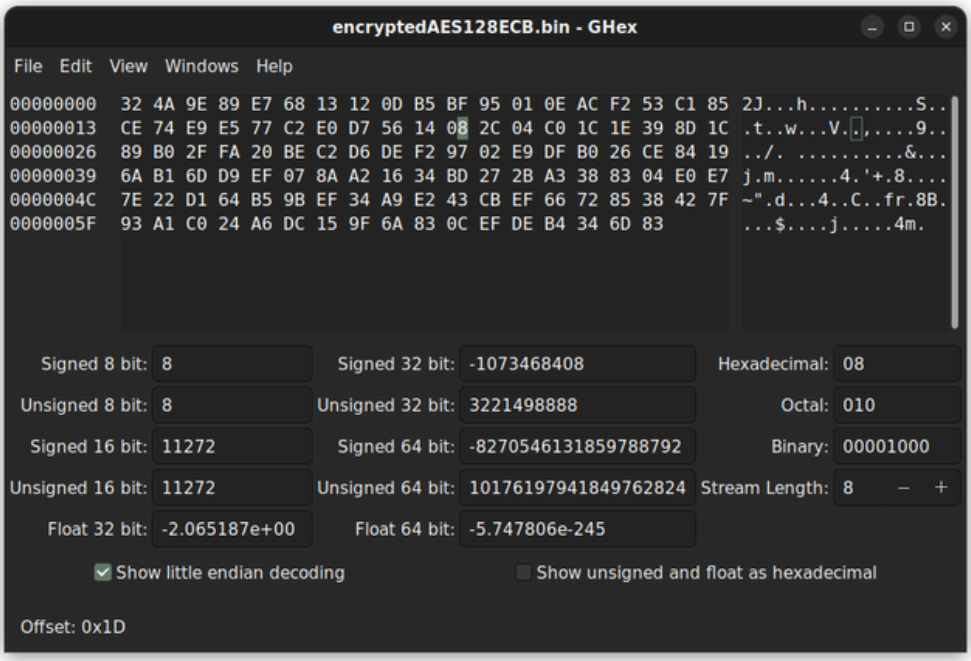


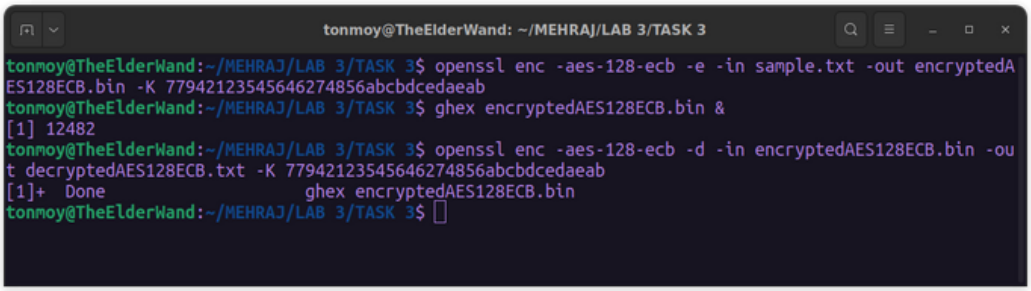

**FOR ECB MODE**

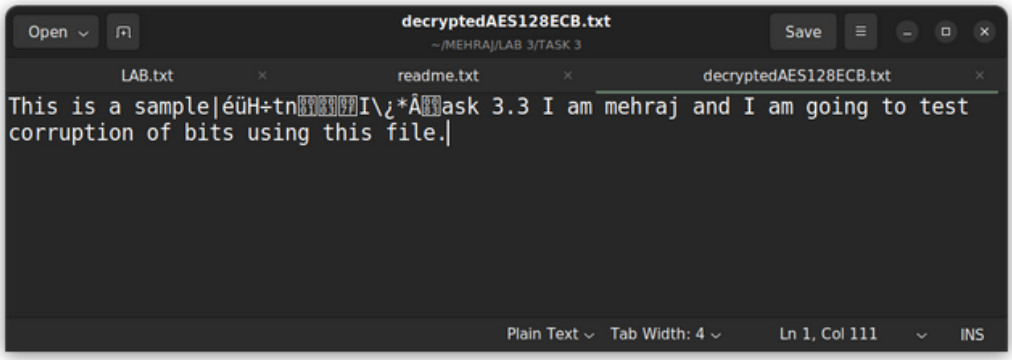
openssl enc -aes-128-ecb -e -in sample.txt -out encryptedAES128ECB.bin
-K 77942123545646274856abcbdcedaeab
ghex encryptedAES128ECB.bin &

Then I went to 30th bit and changed the HEX value

openssl enc -aes-128-ecb -d -in encryptedAES128ECB.bin -out decryptedAES128ECB.txt
-K 77942123545646274856abcbdcedaeab






**FOR CFB MODE**

openssl enc -aria-128-cfb -e -in sample.txt -out encryptedAES128CFB.bin
-K 77942123545646274856abcbdcedaeab -iv 33355500033347349994444453555222
ghex encryptedAES128CFB.bin &

Then I went to 30th bit and changed the HEX value

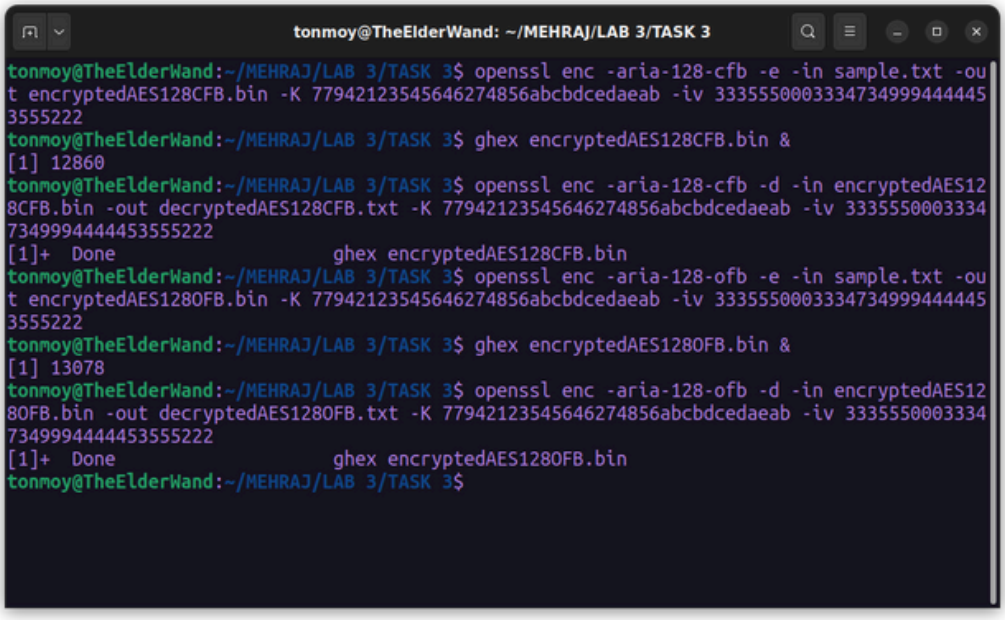
openssl enc -aria-128-cfb -d -in encryptedAES128CFB.bin -out decryptedAES128CFB.txt
-K 77942123545646274856abcbdcedaeab -iv 33355500033347349994444453555222

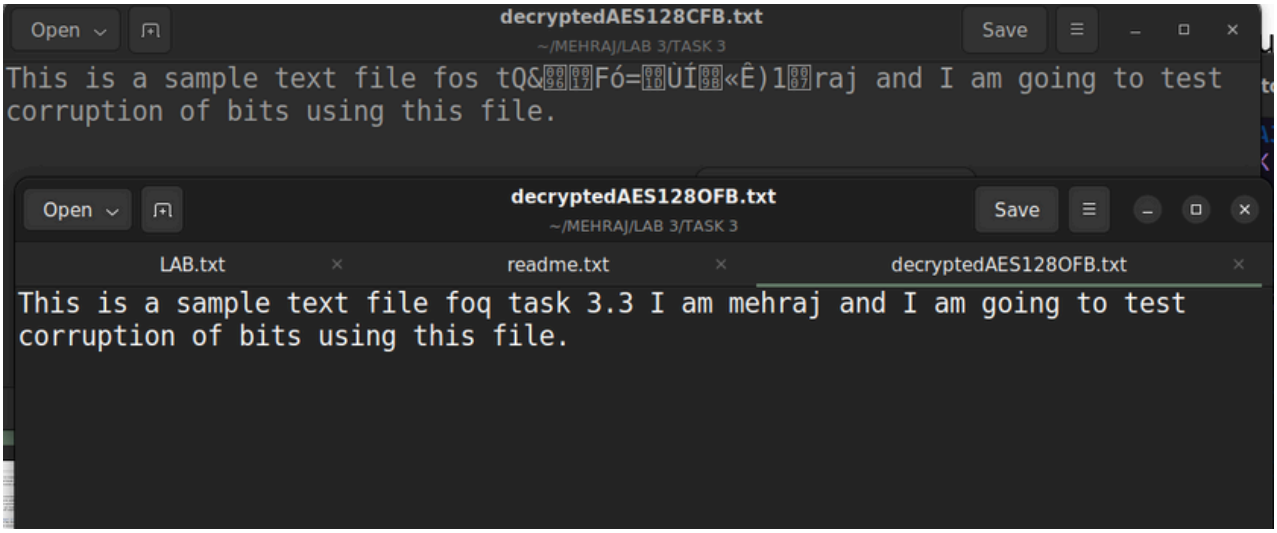
**FOR OFB MODE**

openssl enc -aria-128-ofb -e -in sample.txt -out encryptedAES128OFB.bin
-K 77942123545646274856abcbdcedaeab -iv 33355500033347349994444453555222
ghex encryptedAES128OFB.bin &

Then I went to 30th bit and changed the HEX value

openssl enc -aria-128-ofb -d -in encryptedAES128OFB.bin -out decryptedAES128OFB.txt
-K 77942123545646274856abcbdcedaeab -iv 33355500033347349994444453555222






Here these are the results of CFB & OFB

# ANALYSIS

**ECB Mode**

**Corrupted Information:** "|éüH÷tn□□□l\¿*Âƒ" (16 bytes)

**Explanation:** In ECB mode, each block is encrypted independently. Therefore, the corruption only affects the specific block where it occurred. The rest of the plaintext remains intact.

**CBC Mode:**

**Corrupted Information:** "tÈ3«qvy$Æq÷Vg□4" (16 bytes)

**Explanation:** While CBC mode encrypts blocks in a chained manner, the corruption in one block affects the decryption of subsequent blocks. However, the first block can still be recovered as it only depends on the IV and the first block of ciphertext.

**CFB Mode:**

**Corrupted Information:** "Q&-□Fó=□Ùí› «Ê)1□" (16 bytes)

**Explanation:** In CFB mode, the corruption in one ciphertext block affects the decryption of subsequent blocks. However, due to the feedback mechanism, only a part of the subsequent blocks is corrupted. As a result, more information can be recovered compared to CBC mode.

**OFB Mode:**

**Corrupted Information:** "q" (1 bytes)

**Explanation:** Similar to CFB mode, the corruption in one ciphertext block affects the decryption of subsequent blocks. However, in OFB mode, the feedback mechanism is independent of the plaintext, resulting in a similar recovery as in CFB mode.

## IMPLICATIONS:

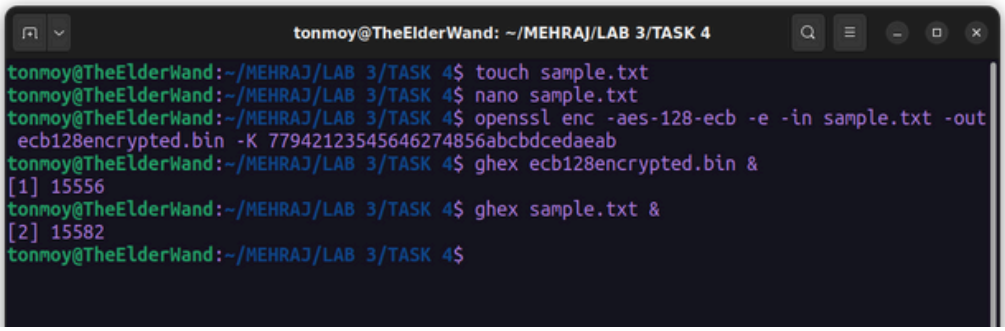
- ECB mode offers the least security and diffusion, as evident from the limited recoverable information.
- CBC mode provides better security compared to ECB but still suffers from partial corruption propagation.
- CFB offers improved diffusion, allowing for more recoverable information compared to CBC mode, although still susceptible to partial corruption propagation.
- OFB gives the best result among them, as it has only 1 corrupted bit and all other bits have been recovered being significant improvements.

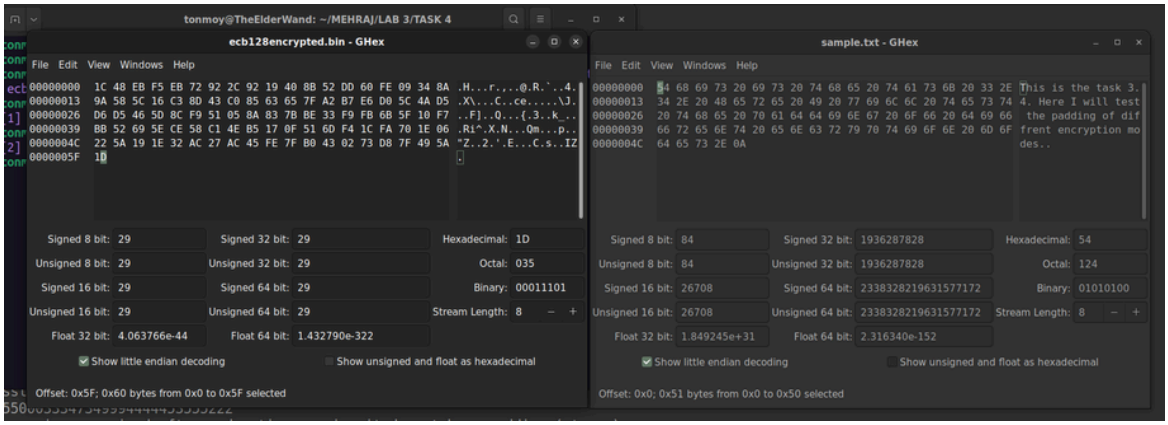
# TASK 3.4: PADDING

Firstly I created a text file smaple.txt

**FOR ECB**

openssl enc -aes-128-ecb -e -in sample.txt -out ecb128encrypted.bin
-K 77942123545646274856abcbdcedaeab
ghex ecb128encrypted.bin &
ghex sample.txt &

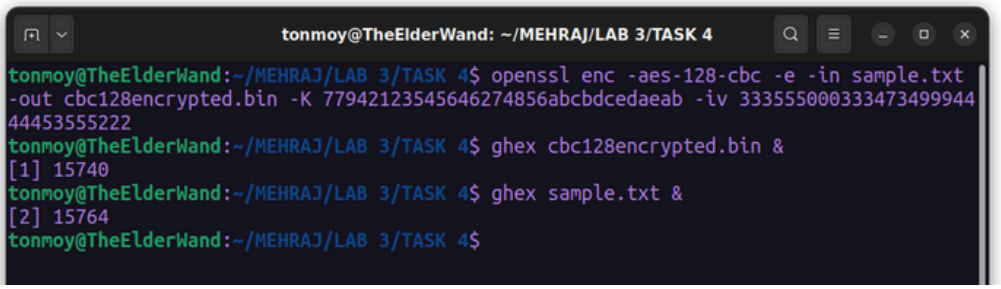


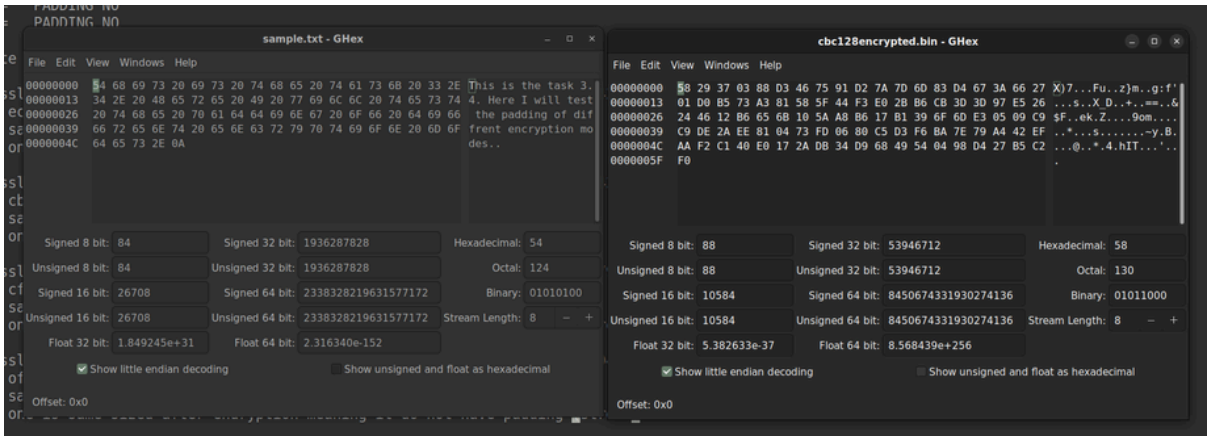




**ECB generates larger output after encryption meaning it has padding**

**FOR CBC**

openssl enc -aes-128-cbc -e -in sample.txt -out cbc128encrypted.bin
-K 7794212354564627485 6abcbdcedaeab -iv 33355500033347349994444453555222
ghex cbc128encrypted.bin &
ghex sample.txt &

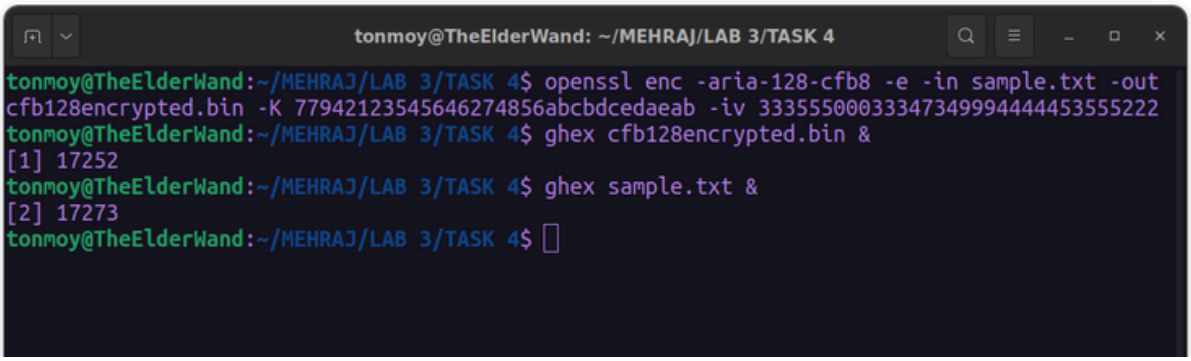


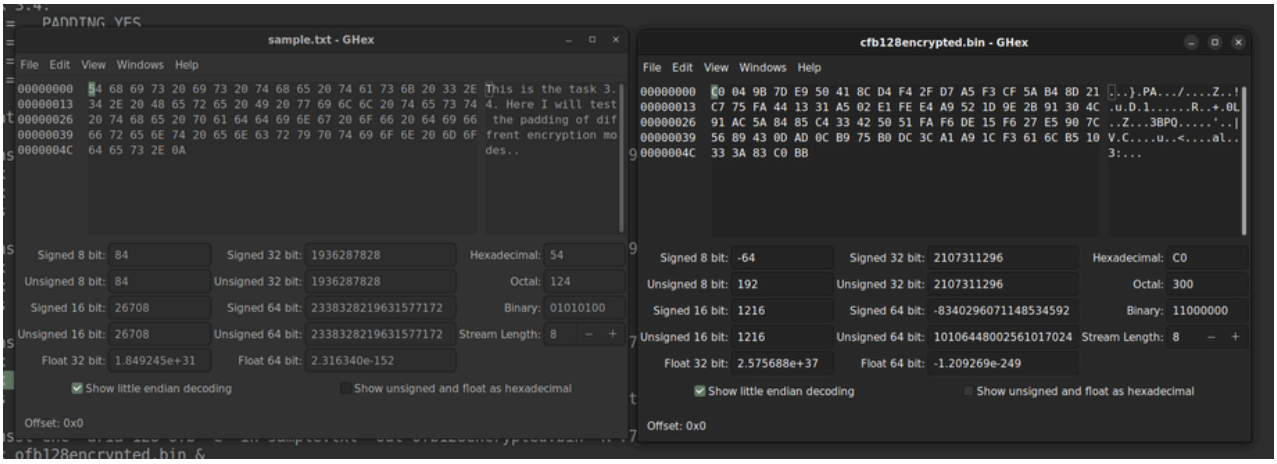




**CBC generates larger output after encryption meaning it has padding**

**FOR CFB**

openssl enc -aria-128-cfb8 -e -in sample.txt -out cfb128encrypted.bin
-K 7794212354564627485 6abcbdcedaeab -iv 33355500033347349994444453555222
ghex cfb128encrypted.bin &
ghex sample.txt &





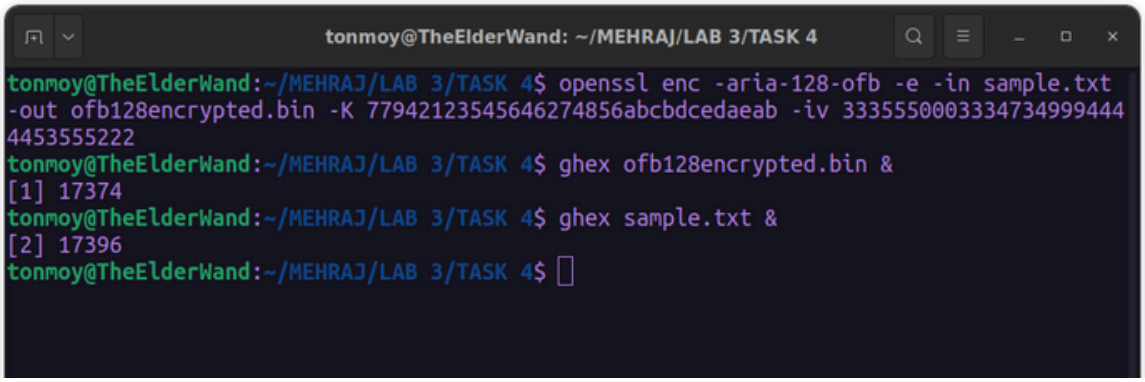

**CFB do not generate larger output after encryption meaning it do not have padding**

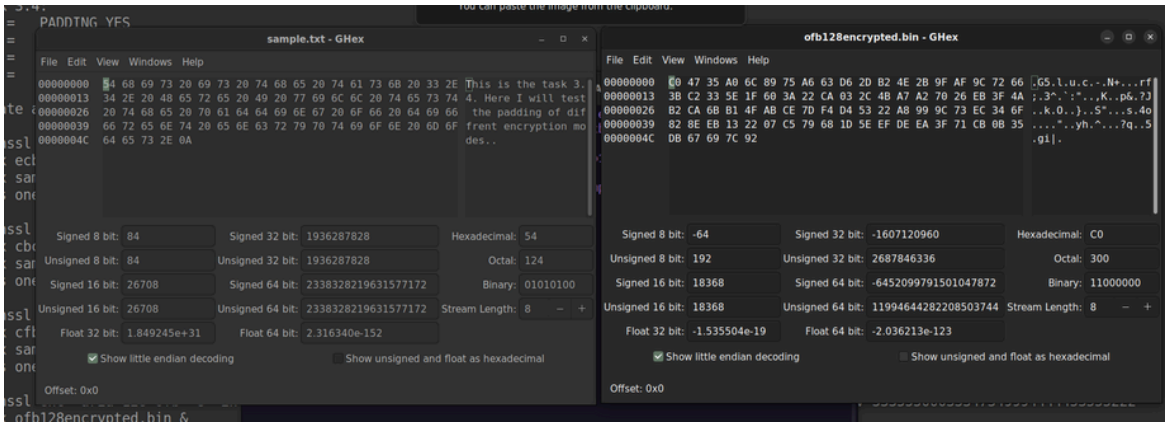
**FOR OFB**

openssl enc -aria-128-ofb -e -in sample.txt -out ofb128encrypted.bin -K 77942123545646274856abcbdcedaeab -iv 33355500033347349994444453555222

ghex ofb128encrypted.bin &

ghex sample.txt &




**OFB do not generate larger output after encryption meaning it do not have padding**

**SO MY FINDINGS ARE:**

**ECB HAS PADDING**
**CBC HAS  PADDING**

**CFB DON'T HAVE PADDING**
**OFB DON'T HAVE PADDING**

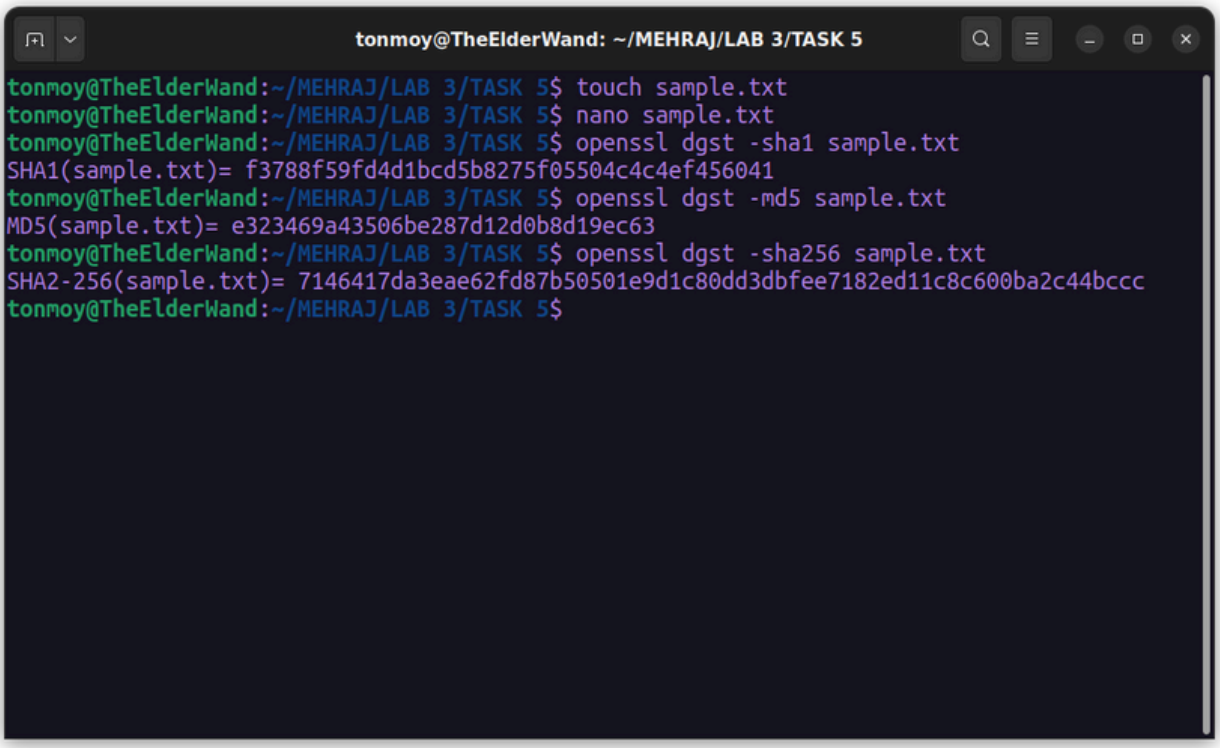
# TASK 3.5: GENERATING MESSAGE DIGEST

I created a text file nammed sample.txt

openssl dgst -sha1 sample.txt
output: f3788f59fd4d1bcd5b8275f05504c4c4ef456041

openssl dgst -md5 sample.txt
output: e323469a43506be287d12d0b8d19ec63

openssl dgst -sha256 sample.txt
output: 7146417da3eae62fd87b50501e9d1c80dd3dbfee7182ed11c8c600ba2c44bccc



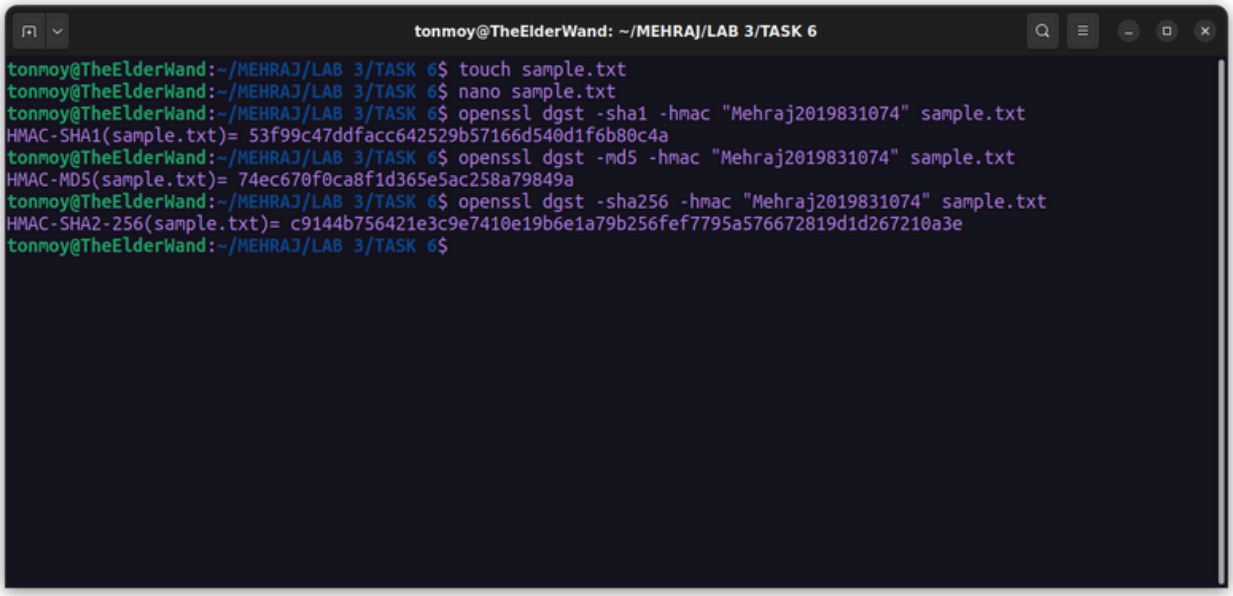
# TASK 3.6: KEYED HASH AND HMAC

I created a text file nammed sample.txt

openssl dgst -sha1 -hmac "Mehraj2019831074" sample.txt
output: 53f99c47ddfacc642529b57166d540d1f6b80c4a

openssl dgst -md5 -hmac "Mehraj2019831074" sample.txt
output: 74ec670f0ca8f1d365e5ac258a79849a

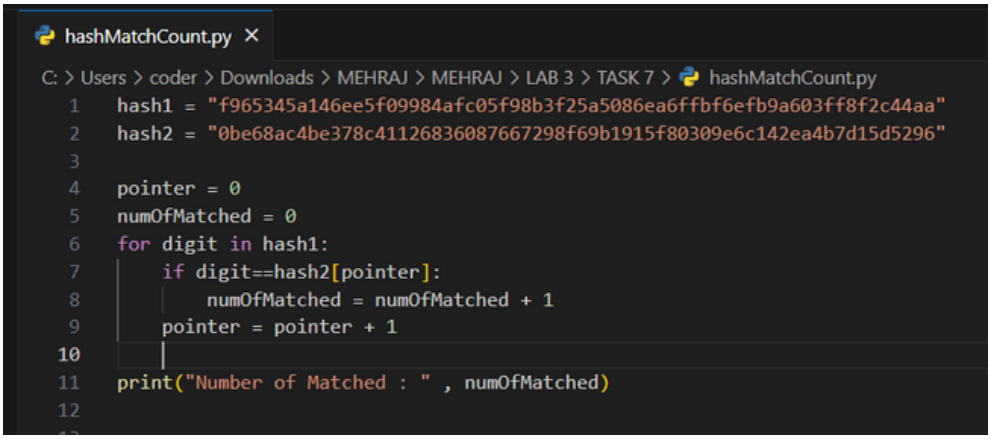
openssl dgst -sha256 -hmac "Mehraj2019831074" sample.txt
output: c9144b756421e3c9e7410e19b6e1a79b256fef7795a576672819d1d267210a3e




# TASK 3.7: KEYED HASH AND HMAC

I created a text file nammed sample.txt

Then I created a program for counting hash match named hashMatchCount.py



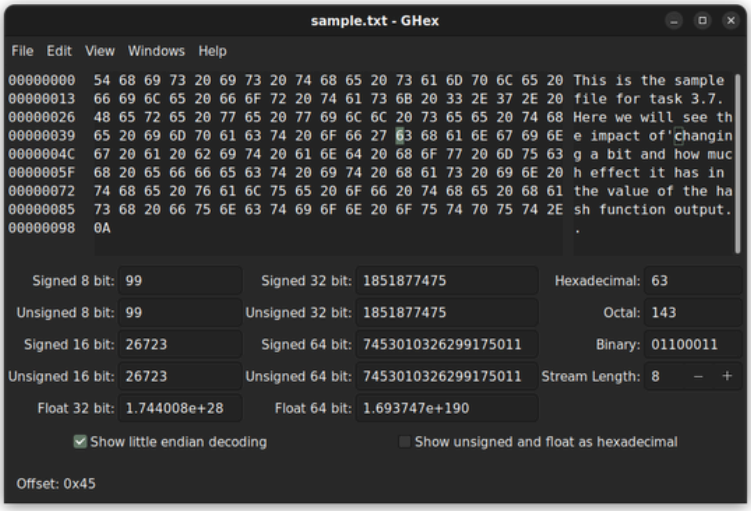
**FOR MD5**

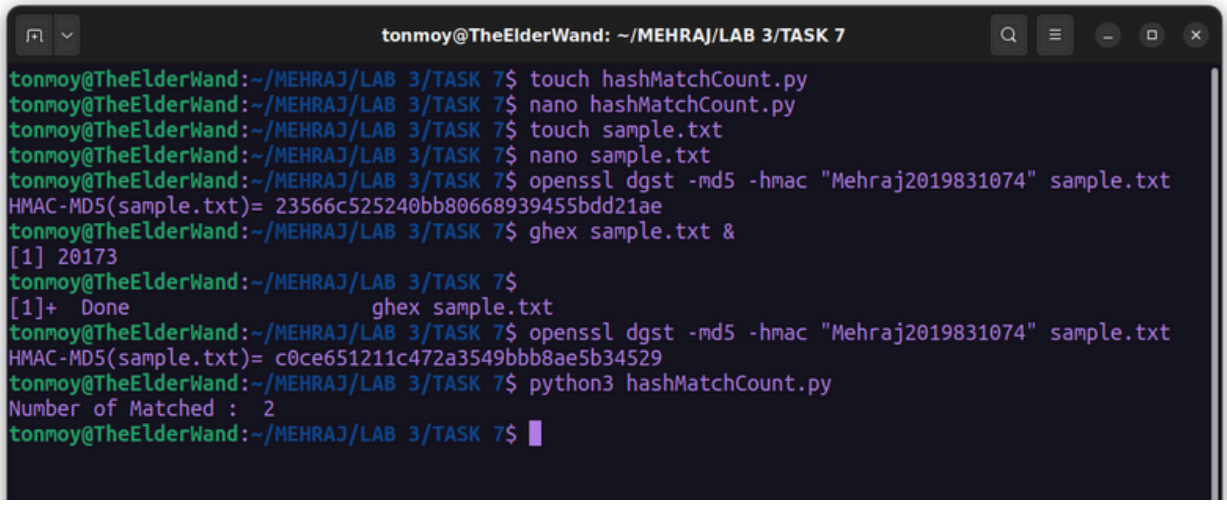
openssl dgst -md5 -hmac "Mehraj2019831074" sample.txt
output: **23566c525240bb80668939455bdd21ae**
ghex sample.txt &

Then I changed a random bit

openssl dgst -md5 -hmac "Mehraj2019831074" sample.txt
output: **c0ce651211c472a3549bbb8ae5b34529**

Then updated the python code (replaced hash values)




Here number of matched characters is: 2

**FOR SHA256**

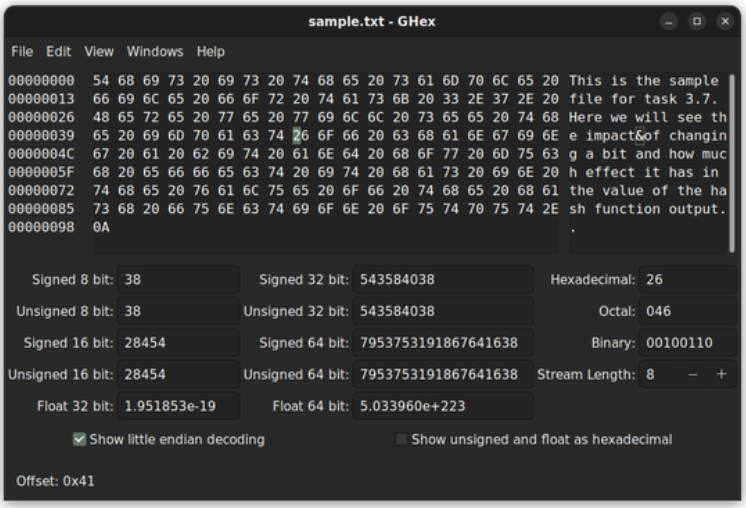
update the text file text.txt to the previous main content

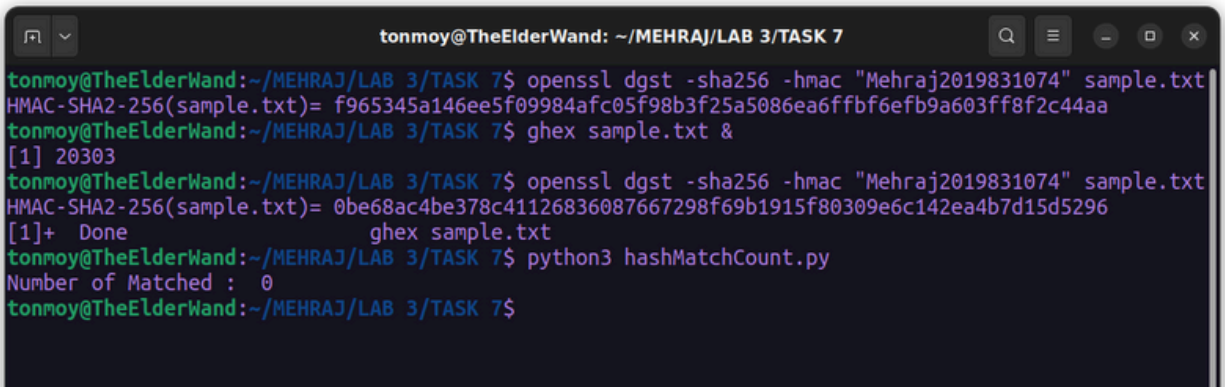
openssl dgst -sha256 -hmac "Mehraj2019831074" text.txt
output:
**923b829a244a667348611ffe93016ddf798224b71a0ad6c650e68f9e10cd1c6e**
ghex text.txt &

Then I changed a random bit

openssl dgst -sha256 -hmac "Mehraj2019831074" text.txt
output:
**5f4a04044aa5e14da6887551c00326cac4abba24355c076c38fb9f8dd6151e8f**

Then updated the python code (replaced hash values)




Here number of matched characters is: 0

So, changing even a bit changes the hash value completely