# IDATT2503 - Cryptography - Autumn 2023

# Cryptography Handout 3

### Exercise 1

a) Given the recursive sequence/LFSR defined by

$$z_{i+4} = z_i + z_{i+1} + z_{i+2} + z_{i+3} (\mathrm{mod}\, 2)$$

What are the periods using the keys

1 $K = 1000$ ?

2 $K = 0011$ ?

3 $K = 1111$ ?

b) What are the periods with the same keys using the following LFSR?

$$z_{i+4} = z_i + z_{i+3} (\mathrm{mod}\, 2)$$

### Exercise 2

Vi define a HMAC as follows:

- Key $K = 1001$
- ipad = 0011
- opad = 0101
- $h$ is the midsquare-hasing, calculationg $x^2 (\mathrm{mod}\, 2^8)$ and retrieving the middle four binary digits. Eg. $1011^2 = 01111001$ (with leading 0), giving us 1110 as hash value.

a) Find the HMAC for the message 0110

b) You receive the message 0111, with HMAC 0100. Is it reason to believe that the message is authenic?

### Oppgave 3

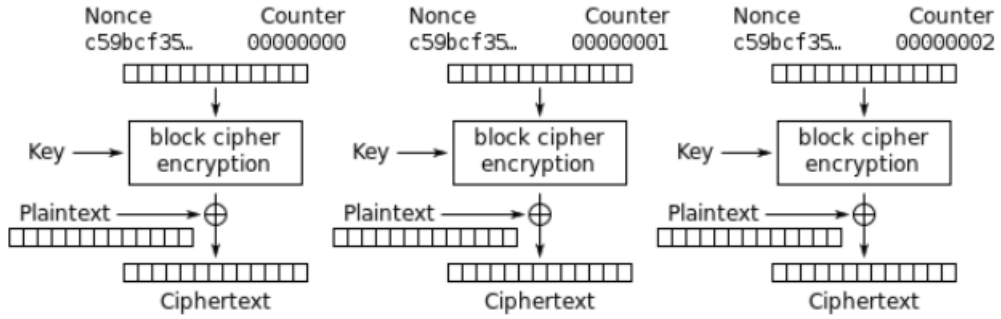
Use the Cæsar cipher, with encryption $e_3(x) = x + 3 \pmod{2^8}$ and find the CBC-MAC to the following two messages:

$$x = 1101\,1111\,1010\,0001$$
$$x' = 0010\,1100\,0001\,1111$$

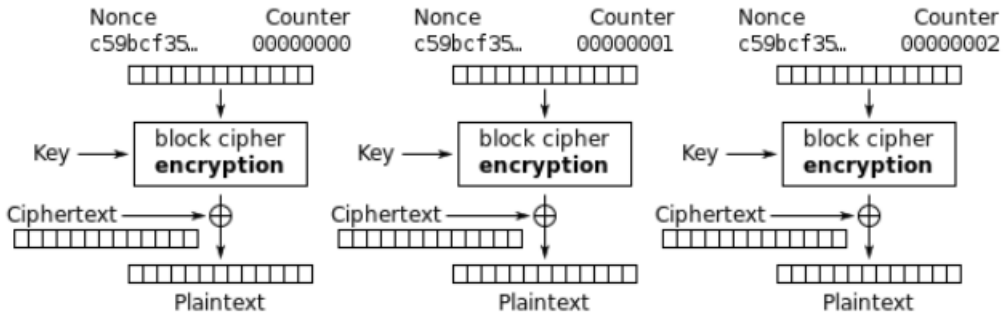
### Exercise 4

We can construct a key-stream by using a block cipher in CTR-mode, by simply encrypting a sequence of values with a block cipher. It will use a *nonce* (initial value) combined with a

counter. Here we will use addition modulo $2^8 = 256$ as the operation combining the nonce and the counter. The counter starts at 0, and add 1 to it for each round.
For the block cipher in parts a)-c) below, we use the SUBBYTES of the AES cipher, which substitutes a byte (8 bits) for another byte using a table lookup (actually a calculation in a certain Galois field, but its not in the curriculum).
Write programs to do the calculations.




Counter (CTR) mode encryption




Counter (CTR) mode decryption

a) Using the nonce = 01100101, write down the first 4 bytes produced with counter values 0,1,2,3.

b) What is the period of the key-stream?

c) Can the computation of the keystream be easily parallelized?

d) You intercept a message which is ecrypted by XOR-ing a key-stream generated by CTR, as described above, but with an unknown block cipher (not the one above). How could information about known plaintexts-ciphertext pairs be used to infer information about the key used?