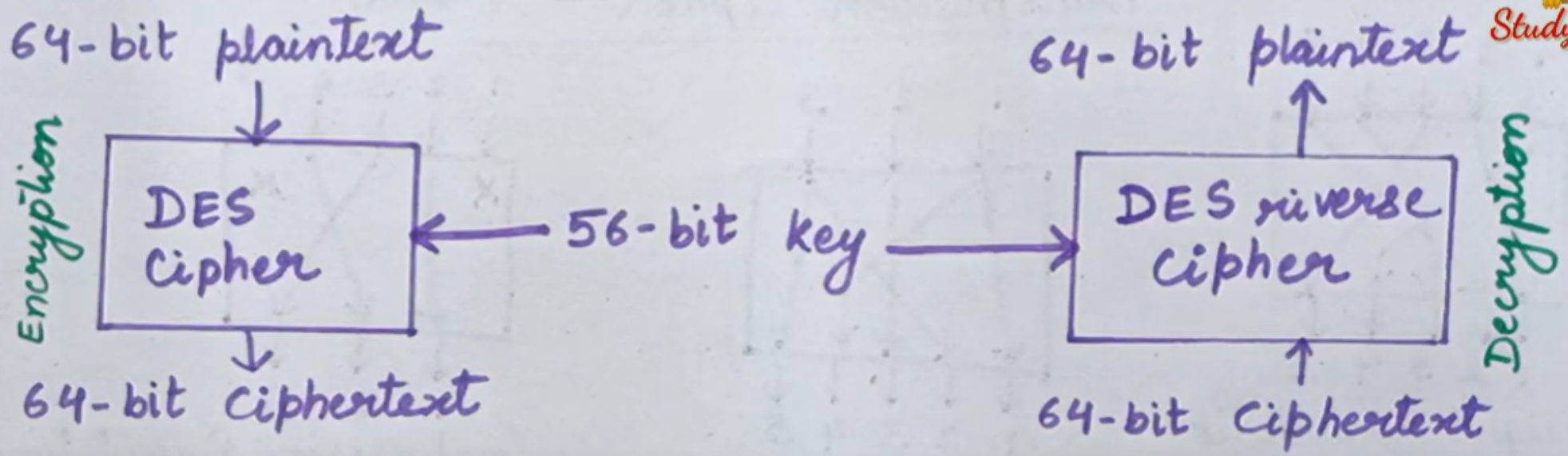
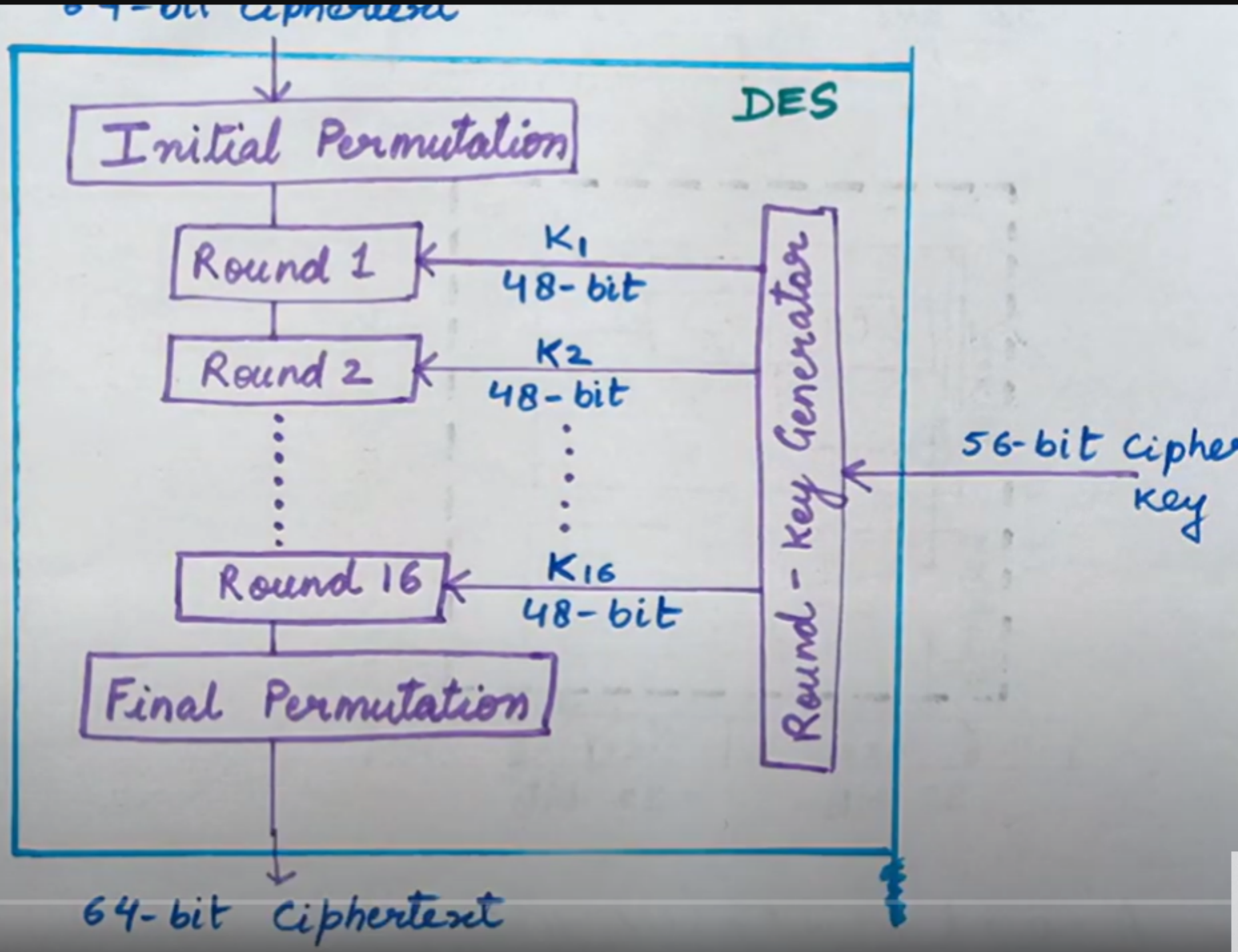
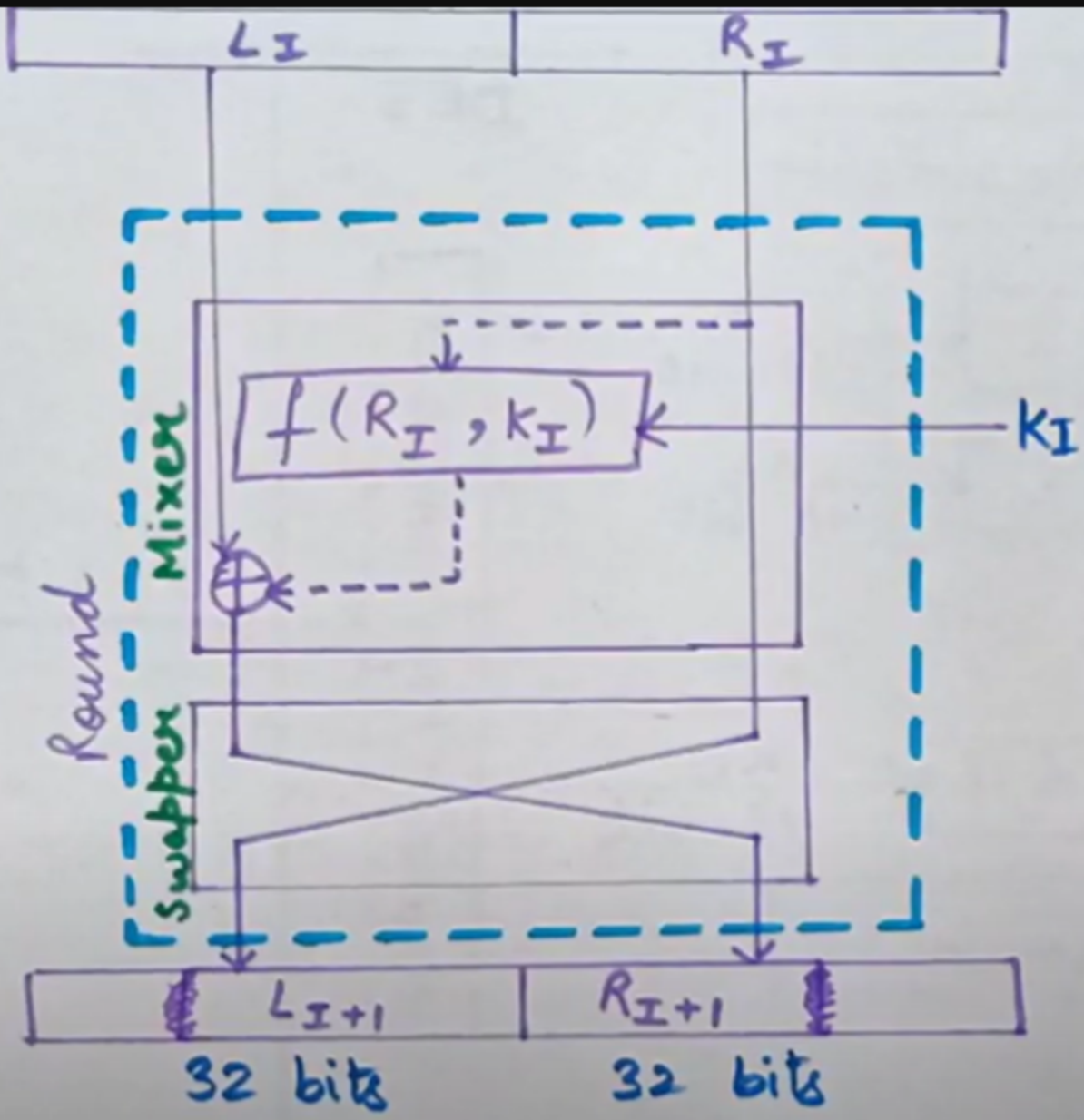
# Data Encryption Standard (DES)

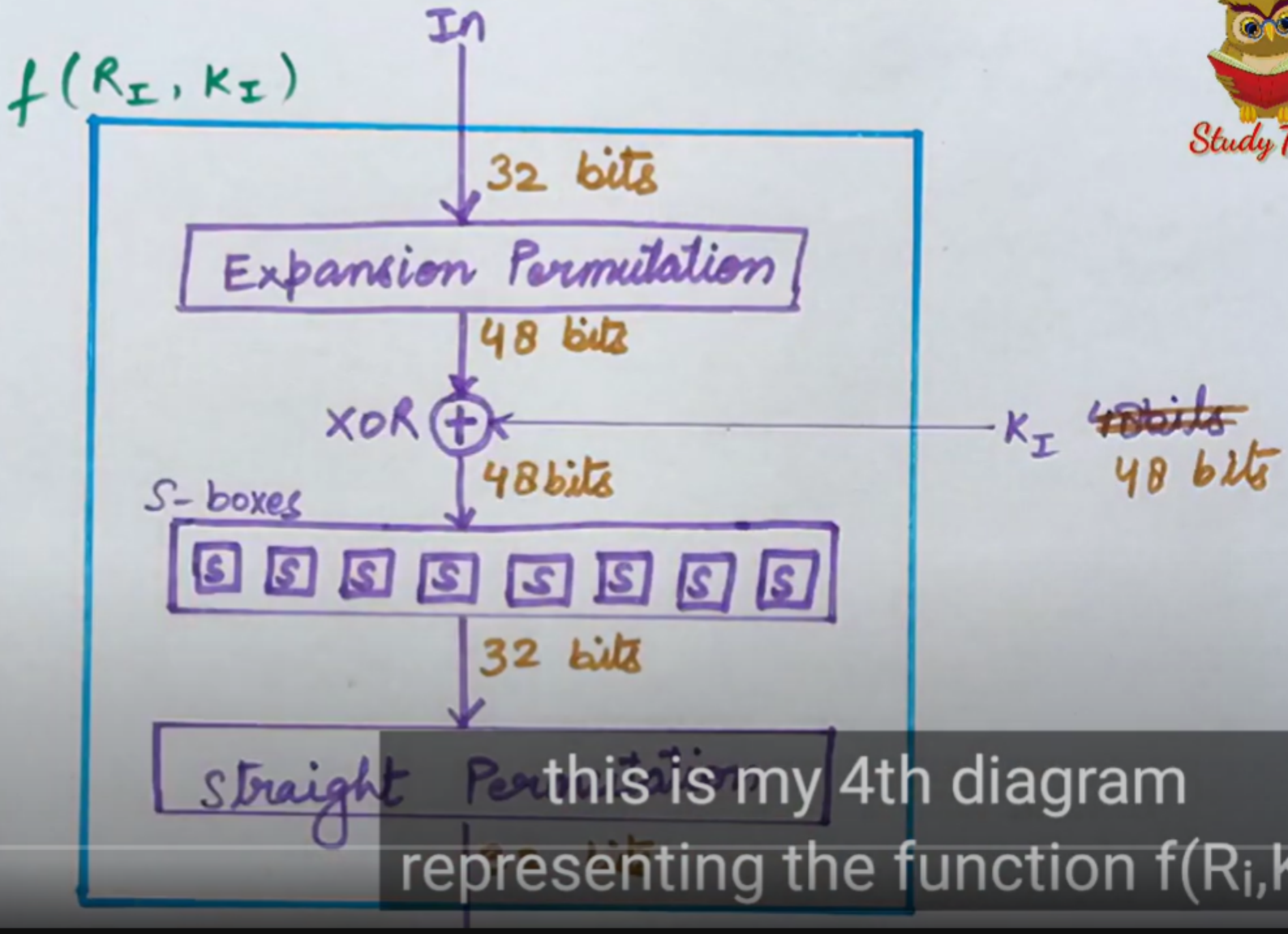



## Encryption and Decryption with DES


64-bit Ciphertext
DES
Initial Permutation
Round 1
K1
48-bit
Round 2
K2
48-bit
Round 16
K16
48-bit
Final Permutation
Round-Key Generator
56-bit Cipher Key
64-bit Ciphertext




A round in DES (encryption site)



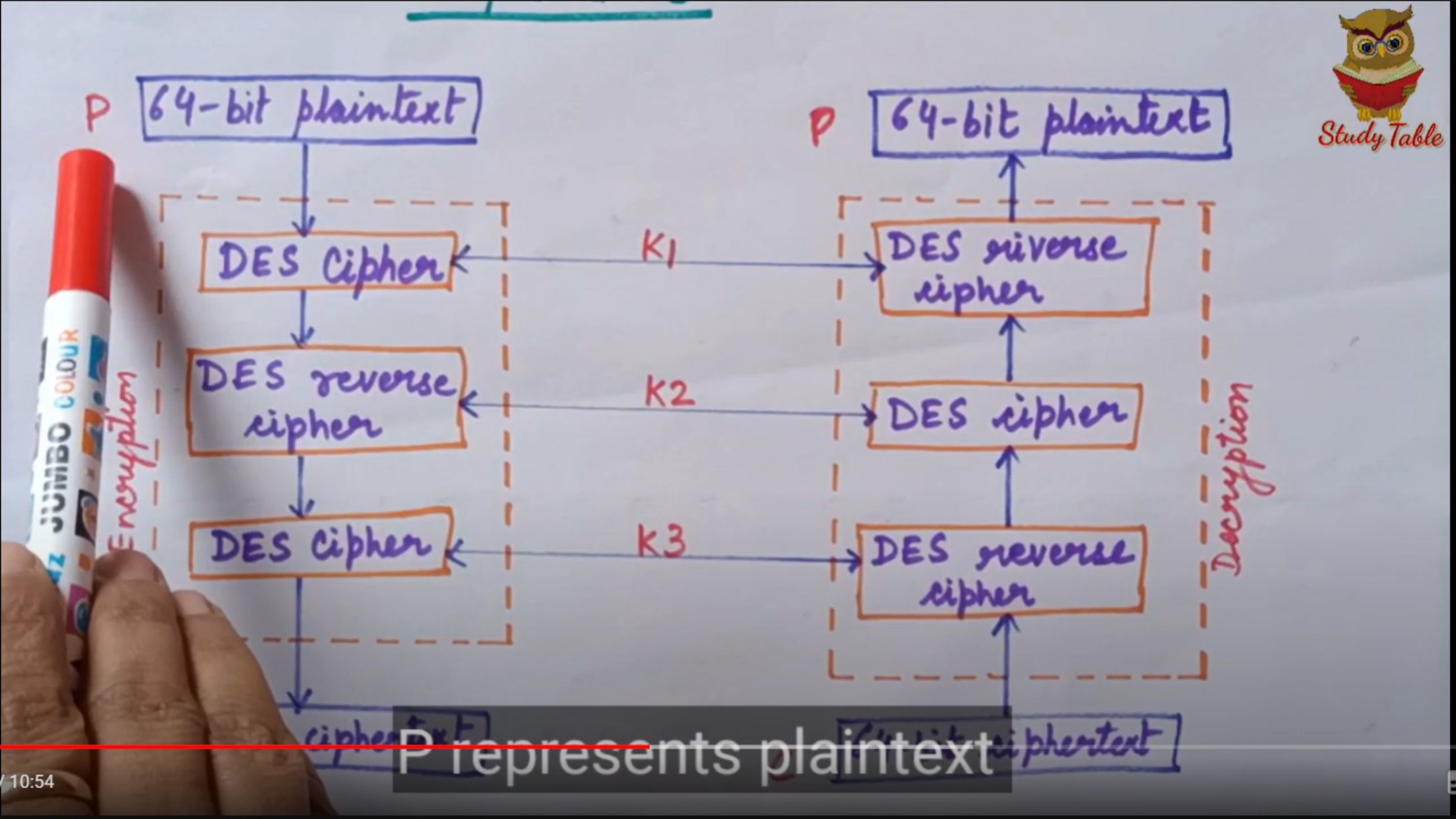

this is my 4th diagram
representing the function f(Ri,K

# DES Analysis

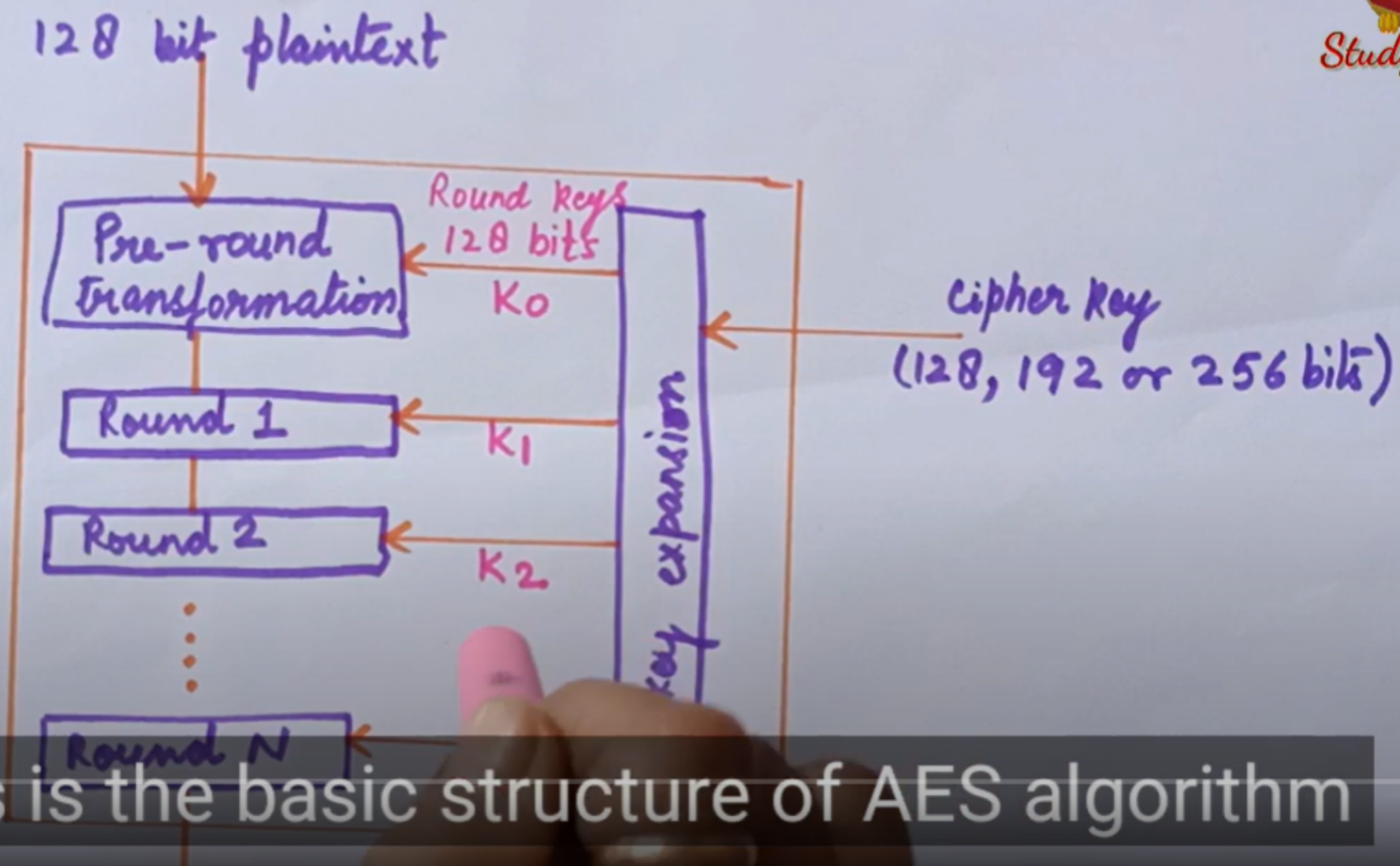
1. Avalanche Effect
2. Completeness Effect

# Triple DES / TDES / TDEA

- 1978, Walter Tuchman
- 1981, Merkle Hellman
  - Symmetric key block cipher
  - 168 bits key size
  - Feistal structure network
  - 48 rounds


P
64-bit plaintext
DES Cipher
DES reverse cipher
DES Cipher
Encryption
K1
K2
K3
P
64-bit plaintext
DES reverse cipher
DES cipher
DES reverse cipher
Decryption
Study Table
P represents plaintext
10:54

# AES




This is the basic structure of AES algorithm

Study Table

14:46

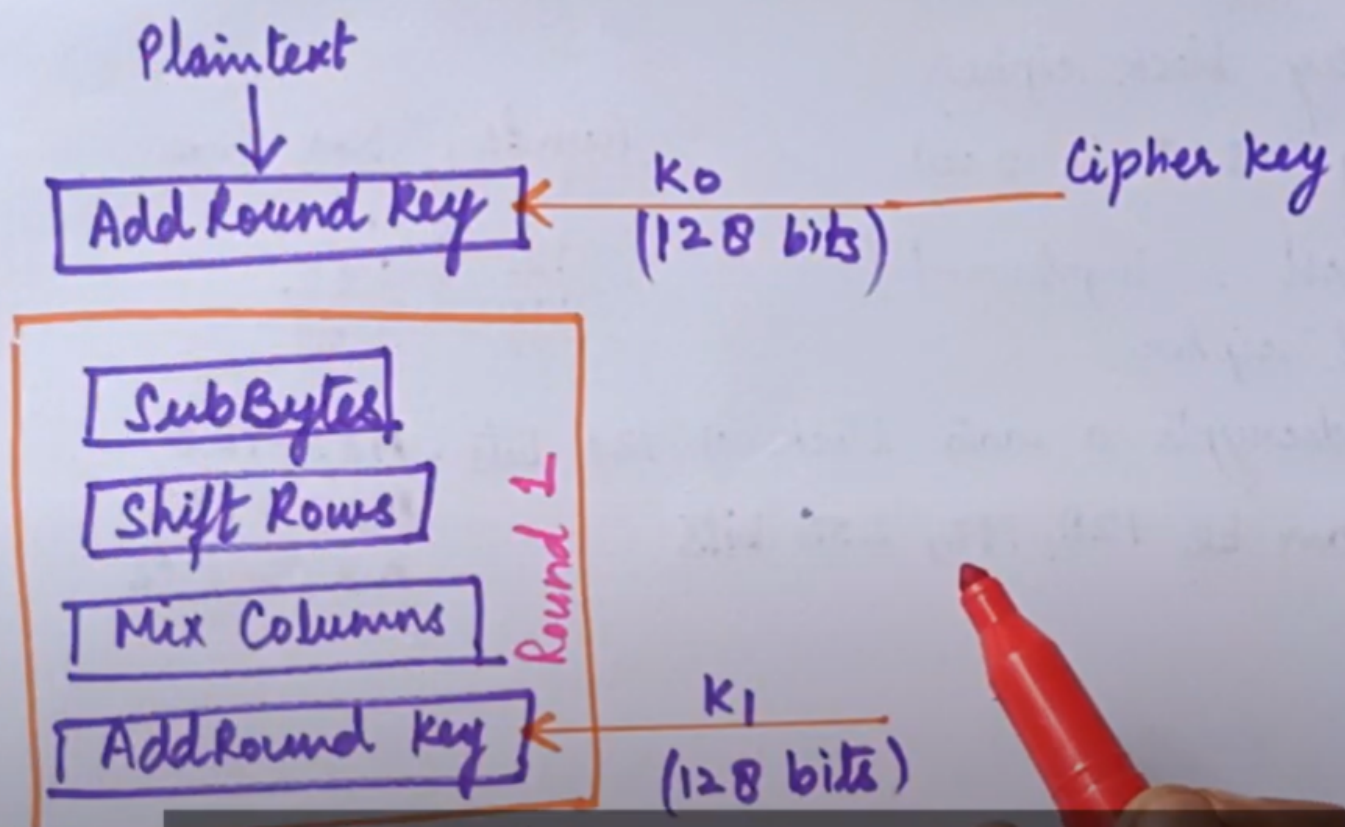
# Advanced Encryption Standard (AES)

- symmetric key block cipher
- published by NIST in 2001
- security, cost & implementation
- non-Feistal cipher
- encrypts & decrypts a data block of 128 bits.

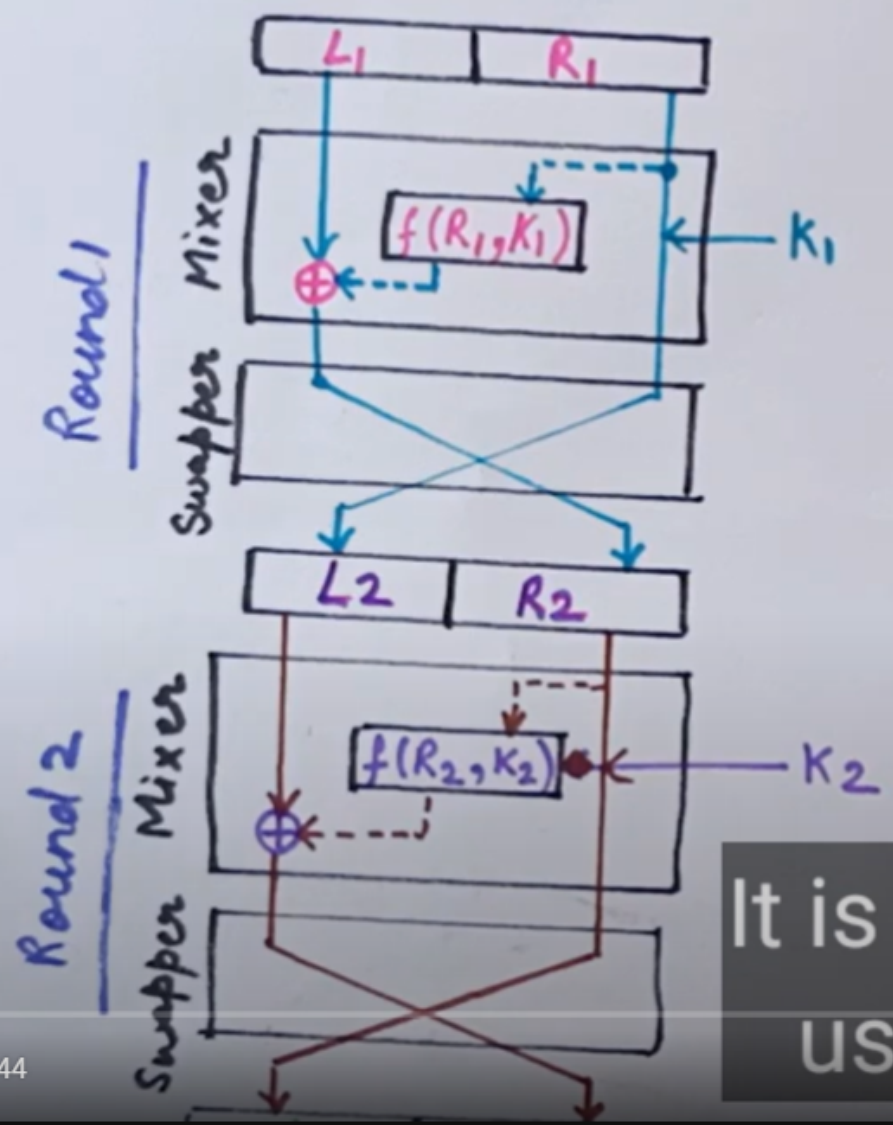
- key size can be 128, 192, 256 bits

128 bit ciphertext

# Structure of each round at encryption site



# Feistal Cipher with two rounds




- named after Horst Feistal
- also known as Luby-Rackoff block cipher / Feistal network
- modern block ciphers r based on Feistal nlws.

- Feistal ciphers –
  DES, 3 DES,
  Blowfish
  Lucifer
  Twofish
  [illegible]
  CAST-128
  FEAL,

It is a symmetric structure which is used to construct block ciphers.

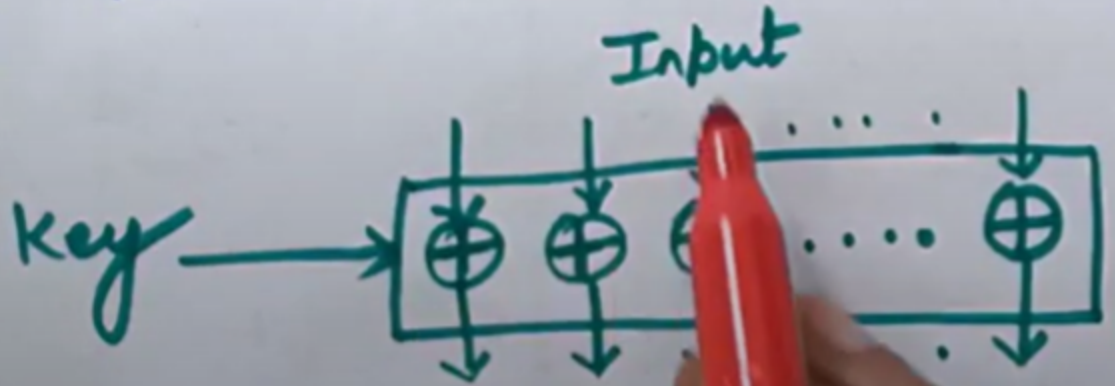
Study Table

4:44

# XOR Cipher

- Simple Modern Cipher
- Needs two data inputs - plaintext & key
- uses same key for encryption & decryption
- A string of text can be encrypted by applying bitwise XOR operator to every character using a given key.
- used in complex ciphers.
- it is simple to implement
- XOR operation is computationally inexpensive.

Input


Input
Key

| P.T | Key | C.T |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

plaintext : KIWI  8 bit ASCII

key : 11110011

| | K | I | W | I |
|---|---|---|---|---|
| | 01001011 | 01001001 | 01010111 | 01001001 |
| ⊕ | 11110011 | 11110011 | 11110011 | 11110011 |
| | 10111000 | 10111010 | 10100100 | 10111010 |

↳ Encryption

Study Table

C.T

C.T 10111000 10111010 10100100 10111010

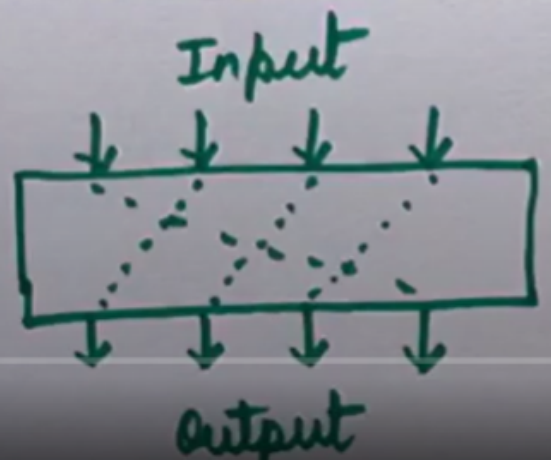
⊕ 11110011 11110011 11110011 11110011

01001011 01001001 01010111 01001001

Plaintext

# Rotation Cipher

- Simple modern cipher
- input bits are rotated to the left or right
- can be keyed or keyless
- special case of transpositional cipher using bits instead characters.
- The decryption algo uses the same key and the opposite rotation direction.




Study Table

5:19

# left rotation -1

1 0 1 1

0 1 1 1

Right Rotation 3

1 0 1 1

= 0 1 1 1

L rotation 2

1101

0111

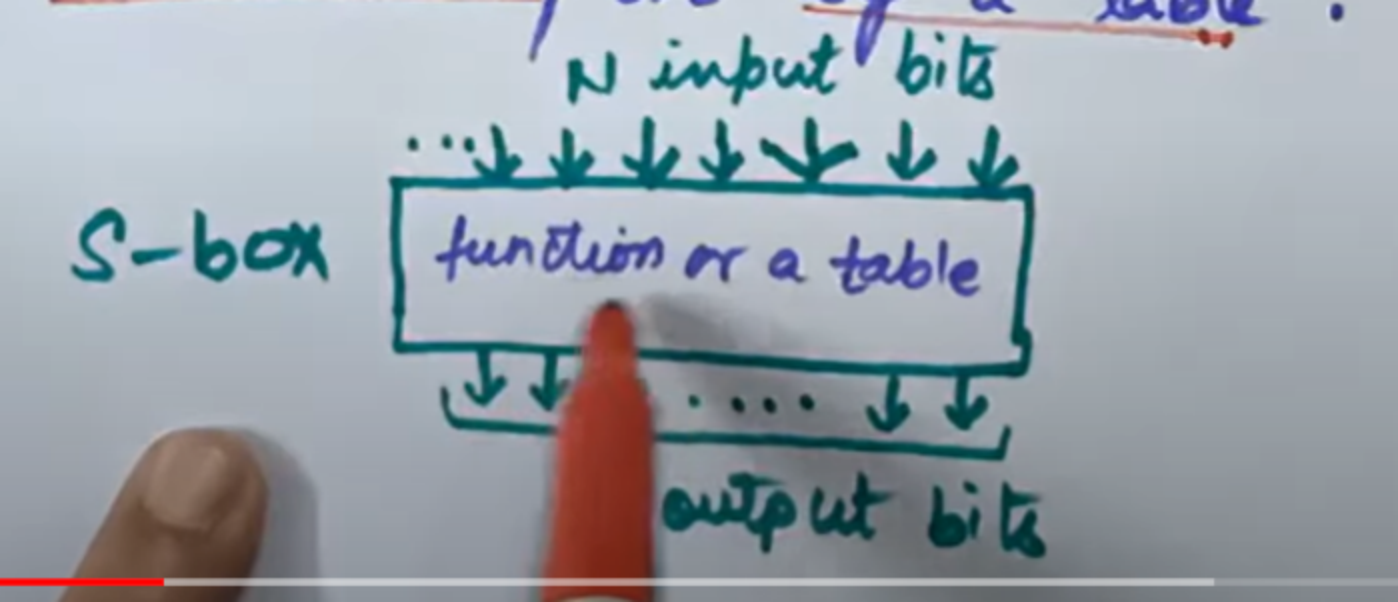
Right rotation 2

0 1 1 1

1 1 0 1

# S-box (Substitution box)

- S-box can have different no. of inputs and outputs.
- basic component of symmetric key algorithms which per substitution.
- can be keyed or keyless, but modern block ciphers ~~use~~ normally use keyless
- even small modification to an S-box could significantly weaken DES.
- used as an intermediate stage of encryption or decryption.
- The function that matches the input to the output may be defined mathematically or by a table.

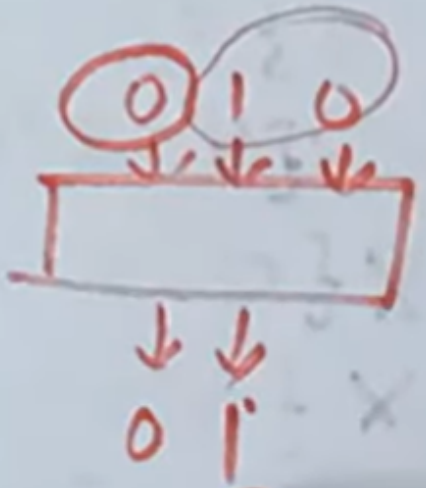

N input bits
S-box
function or a table
output bits

Leftmost bits

| | 00 | 01 | 10 | 11 |
|---|---|---|---|---|
| 0 | 00 | 10 | 01 | 11 |
| 1 | 10 | 00 | 11 | 01 |

Rightmost bits

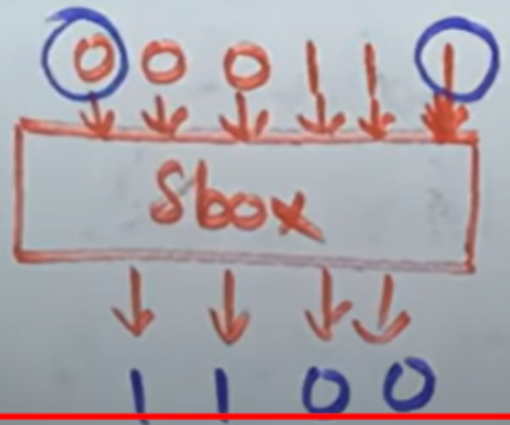
S-box of size 3×2



# mapping 6-bit input into a 4-bit output.

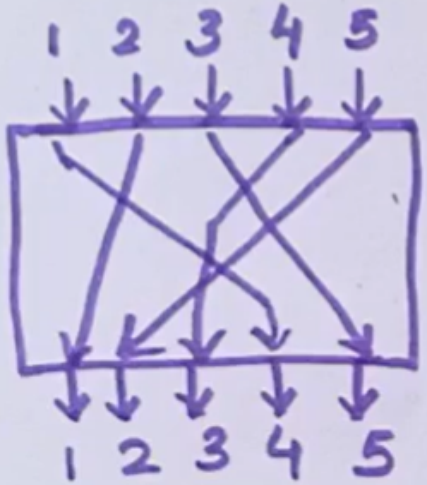
4 Middle bits

| outer bits | 0000 | 0001 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | ..... |
|---|---|---|---|---|---|---|---|---|---|
| 00 | 0010 | 1100 | 0100 | 0001 | 0111 | 1010 | 1011 | 0110 | .... |
| 01 | 1110 | 1011 | 0010 | 1100 | 0100 | 0111 | 1101 | 0001 | .... |
| 10 | 0100 | 0010 | 0001 | 1011 | 1010 | 1101 | 0111 | 1000 | .... |
| 11 | 1011 | 1000 | 1100 | 0111 | 0001 | 1110 | 0010 | 1101 | .... |

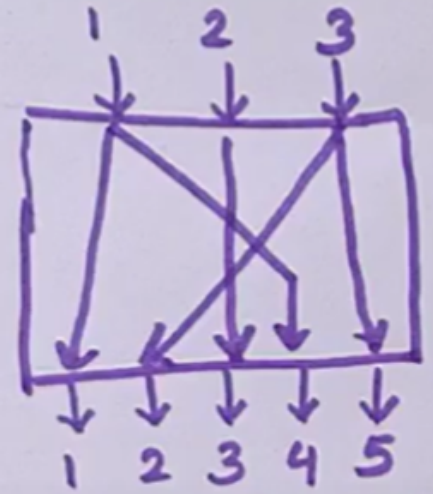


# Permutation Box (P- box)

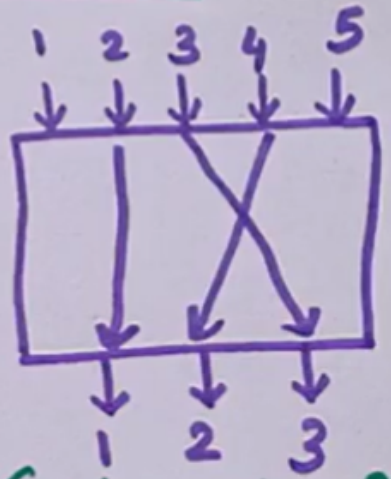
## or Transposition Cipher — P-Box




straight Permutation

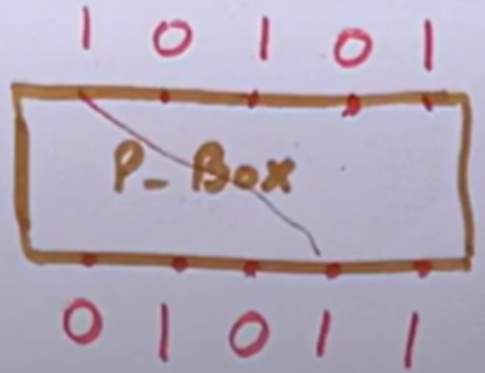


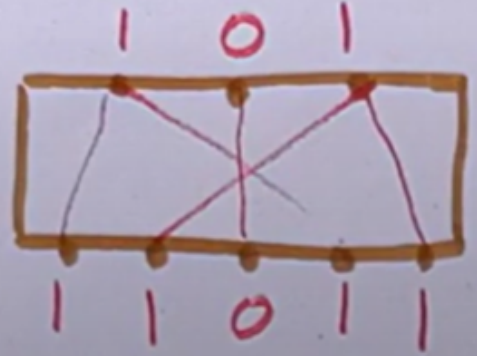

Expansion Permutation

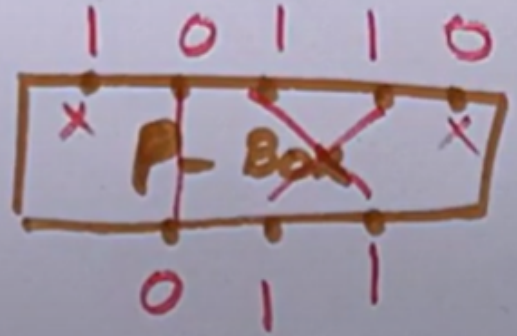



Compression Permutation

Study Table


1 0 1 0 1
P-Box
0 1 0 1 1


1 0 1
1 1 0 1 1


1 0 1 1 0
P-Box
0 1 1