Polyalphabetic Ciphers

- ❑ A polyalphabetic cipher is any cipher based on substitution, using multiple substitution alphabets.
- ❑ polyalphabetic cipher techniques have the following features in common:
  - ❑A set of related monoalphabetic substitution rules is used.
  - ❑A key determines which particular rule is chosen for a given transformation.

Polyalphabetic Ciphers Encryption

❑ Assume

a	b	c	d	e	f	g	h	i	j	k	l	m
0	1	2	3	4	5	6	7	8	9	10	11	12

n	o	p	q	r	s	t	u	v	w	x	y	z
13	14	15	16	17	18	19	20	21	22	23	24	25

❑ Then We set these Rules:

Polyalphabetic Ciphers Encryption

❑ Then We set Key as Rules:

1) Shift the first letter three position to the right

2) Shift the second letter five position to the right

3) Shift the third letter seven position to the right

❑ Given Plaintext = security

Polyalphabetic Ciphers Encryption

❑ Given Plaintext = security

1) Divide Plaintext to three words

a	b	c	d	e	f	g	h	i	j	k	l	m
0	1	2	3	4	5	6	7	8	9	10	11	12

n	o	p	q	r	s	t	u	v	w	x	y	z
13	14	15	16	17	18	19	20	21	22	23	24	25

2) P= sec uri ty

3) C= VJJ XWP WD

Polyalphabetic Ciphers Decryption

❑ Then We set Key as Rules: (reverse)

1) Shift the first letter three position to the left
2) Shift the second letter five position to the left
3) Shift the third letter seven position to the left

❑ Given Ciphertext = VJJXWPWD

Polyalphabetic Ciphers Decryption

❑ Given C= VJJXWPWD

1) Divide Plaintext to three words as your rules number

a	b	c	d	e	f	g	h	i	j	k	l	m
0	1	2	3	4	5	6	7	8	9	10	11	12

n	o	p	q	r	s	t	u	v	w	x	y	z
13	14	15	16	17	18	19	20	21	22	23	24	25

2) C= VJJ XWP WD

3) C= SEC URI TY

Vigenère Cipher

- The Vigenère cipher, was invented by a Frenchman, Blaise de Vigenère in the 16th century.

- Vigenère cipher is a simple polyalphabetic cipher

Vigenère Cipher

- ❑ $C_i = (P_i + K) mod\ 26$
- ❑ $P_i = (C_i - K) mod\ 26$

❑Repeating key

Vigenère Cipher Encryption

- ❑ K=deceptive
- ❑ P=we are discovered save yourself

```
key:            deceptivedeceptivedeceptive
plaintext:      wearediscoveredsaveyourself
```

a	b	c	d	e	f	g	h	i	j	k	l	m
0	1	2	3	4	5	6	7	8	9	10	11	12

n	o	p	q	r	s	t	u	v	w	x	y	z
13	14	15	16	17	18	19	20	21	22	23	24	25

Vigenère Cipher Encryption

key: *deceptivedeceptivedeceptive*

plaintext: wearediscoveredsaveyourself

key	3	4	2	4	15	19	8	21	4	3	4	2	4	15
plaintext	22	4	0	17	4	3	8	18	2	14	21	4	17	4
ciphertext	25	8	2	21	19	22	16	13	6	17	25	6	21	19

key	19	8	21	4	3	4	2	4	15	19	8	21	4
plaintext	3	18	0	21	4	24	14	20	17	18	4	11	5
ciphertext	22	0	21	25	7	2	16	24	6	11	12	6	9

Vigenère Cipher Encryption

❑ Result

key:	*deceptivedeceptivedeceptive*
plaintext:	wearediscoveredsaveyourself
ciphertext:	ZICVTWQNGRZGVTWAVZHCQYGLMGJ

Vigenère Cipher Encryption

- ❑The strength of Vigenère Cipher is that there are multiple ciphertext letters for each plaintext letter

Vigenère Cipher Decryption

- □ decryption simply works in reverse
- □ $P_i = (C_i - K) mod\ 26$

ciphertext:	ZICVTWQNGRZGVTWAVZHCQYGLMGJ
key:	*deceptivedeceptivedeceptive*
plaintext:	wearediscoveredsaveyourself

Autokey Cipher

- ❑An autokey cipher (also known as the autoclave cipher) is a cipher which incorporates the message (the plaintext) into the key.
- ❑ $P = \{p_1, p_2, p_3, \dots, p_n\}$
- ❑ $K = \{k_1, p_1, p_2, p_3, \dots, p_{n-1}\}$
- ❑ $C = \{c_1, c_2, c_3, \dots, c_n\}$

Autokey Cipher

- $C_i = (P_i + K_i) mod\ 26$
- $P_i = (C_i - K_i) mod\ 26$

a	b	c	d	e	f	g	h	i	j	k	l	m
0	1	2	3	4	5	6	7	8	9	10	11	12

n	o	p	q	r	s	t	u	v	w	x	y	z
13	14	15	16	17	18	19	20	21	22	23	24	25

Autokey Cipher Encryption

- ❑ K=m
- ❑ P=attack is today

Plaintext	a	t	t	a	c	k	i	s	t	o	d	a	y
P Value	0	19	19	0	2	10	8	18	19	14	3	0	24
Key	12	0	19	19	0	2	10	8	18	19	14	3	0
C Value	12	19	12	19	2	12	18	0	11	7	17	3	24
Ciphertext	m	t	m	t	c	m	s	a	l	h	r	d	y

Autokey Cipher Decryption

- ❑ K=m
- ❑ C=mtmtcmsalhrdy

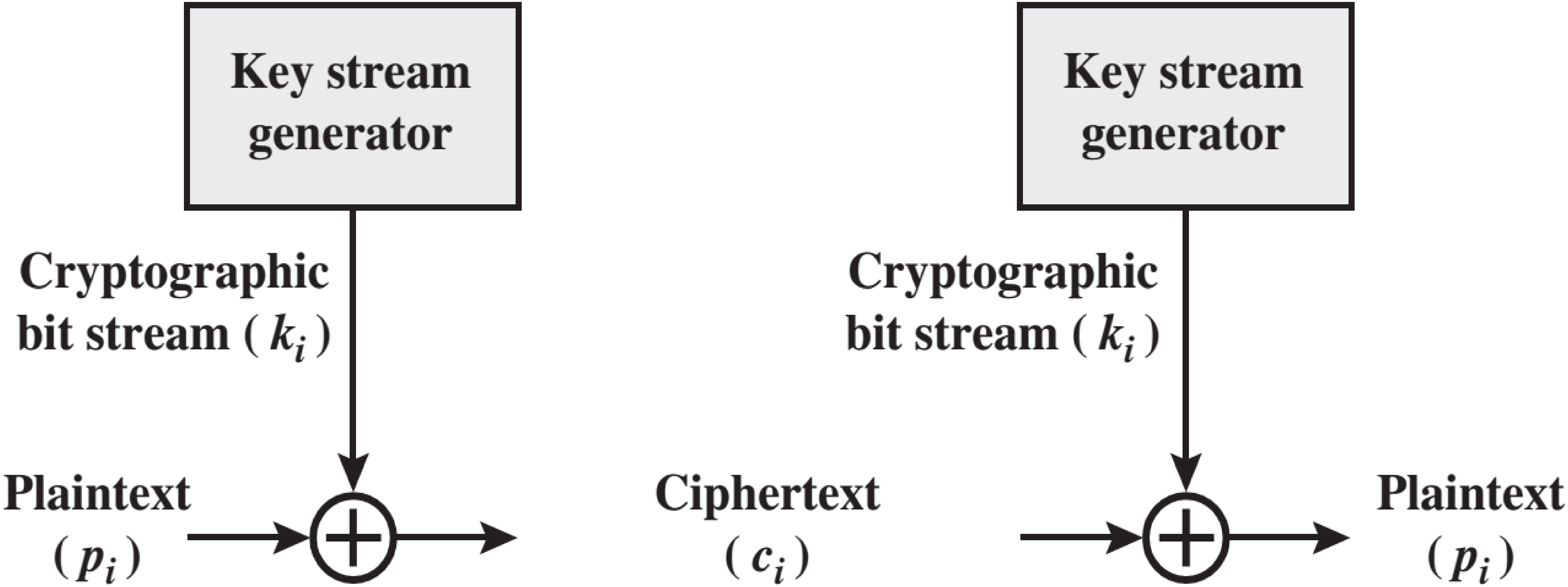
Ciphertext	m	t	m	t	c	m	s	a	l	h	r	d	y
C Value	12	19	12	19	2	12	18	0	11	7	17	3	24
Key	12	0	19	19	0	2	10	8	18	19	14	3	0
P Value	0	19	19	0	2	10	8	18	19	14	3	0	24
Plaintext	a	t	t	a	c	k	i	s	t	o	d	a	y

Vernam Cipher

- Vernam Cipher was introduced by an AT&T engineer named Gilbert Vernam in 1918.

- The ultimate defense against such a cryptanalysis is to choose a keyword that is as long as the plaintext and has no statistical relationship to it.

Vernam Cipher



Vernam Cipher

- ❑ Encryption
  - ➢ $C = P\ XOR\ K$

- ❑ Decryption
  - ➢ $P = C\ XOR\ K$

Vernam Cipher Encryption

- ❑ P=11100011101010101101
- ❑ K=1001010101

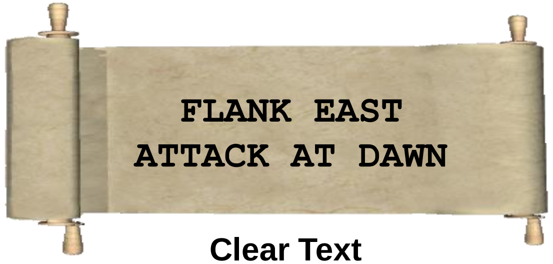
- ❑ P=11100011101010101101
- ❑ K=10010101011001010101
- ❑ C=01110110110011111000

Vernam Cipher Decryption

- ❑ C=01110110110011111000
- ❑ K=10010101011001010101
- ❑ P=11100011101010101101

Transposition Ciphers

1

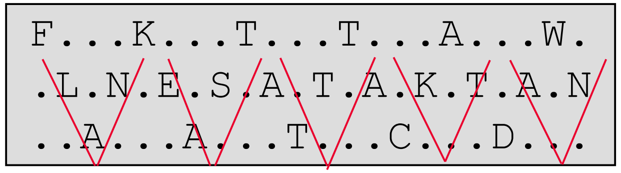


FLANK EAST
ATTACK AT DAWN

Clear Text

The clear text message would be encoded using a key of 3.

2



```
F...K...T...T...A...W.
.L.N.E.S.A.T.A.K.T.A.N
..A...A...T...C...D...
```

Use a rail fence cipher and a key of 3.

3

FKTTAW
LNESATAKTAN
AATCD

Ciphered Text

The clear text message would appear as follows.

Transposition Techniques

- ❑ Transposition Techniques performing some sort of permutation on the plaintext letters (reorder the position of letters in plaintext).

- ❑ Types:
  - Rail Fence Cipher
  - Row Transposition Cipher

Rail Fence Cipher Encryption

- ❑ P= meet me after the toga party
- ❑ K=2

$$1)\ p = \begin{bmatrix} m & e & m & a & t & r & h & t & g & p & r & y \\ e & t & e & f & e & t & e & o & a & a & t & \end{bmatrix}$$

2) C=mematrhtgpryetefeteoaat

Rail Fence Cipher Decryption

- ❑ C=mematrhtgpryetefeteoaat
- ❑ K=2

$$1)\ C = \begin{bmatrix} m & e & m & a & t & r & h & t & g & p & r & y \\ e & t & e & f & e & t & e & o & a & a & t & \end{bmatrix}$$

2) P= meetmeafterthetogaparty

Row Transposition Cipher Encryption

- ❑ P= attack postponed until two am

- ❑ K= 4312567

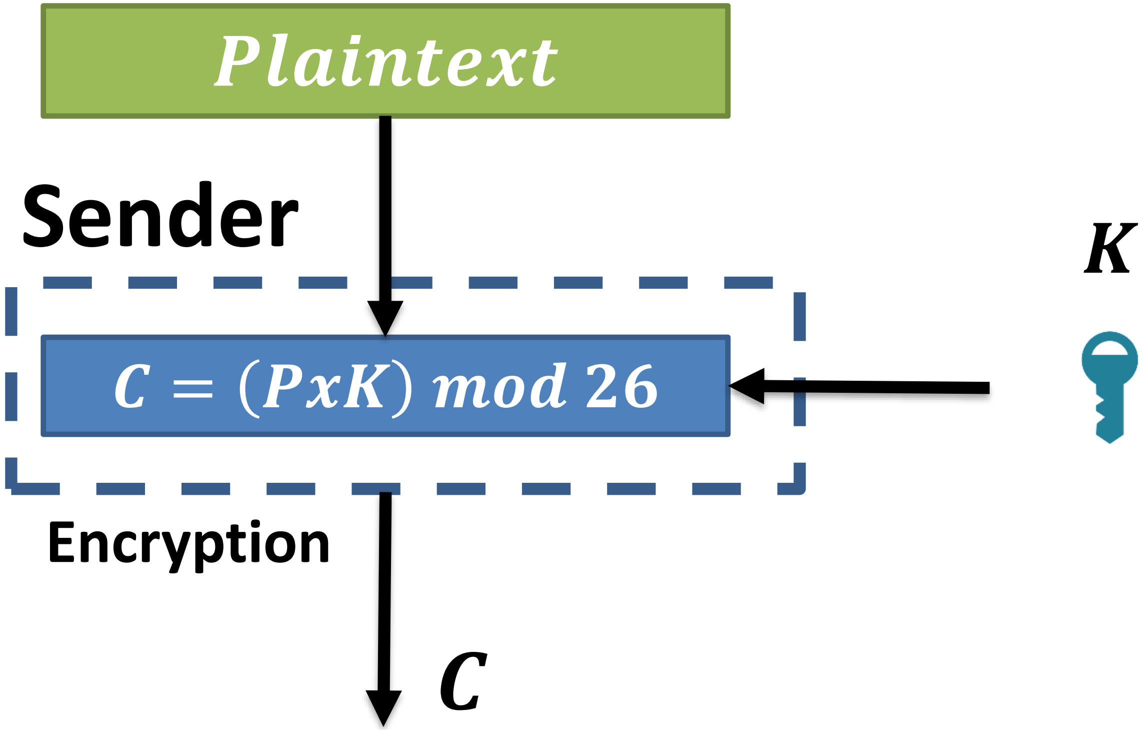
- ❑ $C = \begin{pmatrix} 4 & 3 & 1 & 2 & 5 & 6 & 7 \\ a & t & t & a & c & k & p \\ o & s & t & p & o & n & e \\ d & u & n & t & i & l & t \\ w & o & a & m & x & x & x \end{pmatrix} = ttnaaptmtsuoaodwcoixknlxpetx$

Row Transposition Cipher Decryption

- C= $ttnaaptmtsuoaodwcoixknlxpetx$ = Len(C)=28
- K= 4312567
- Each Column have 28/7= 4 letter
- $P = \begin{pmatrix} 4 & 3 & 1 & 2 & 5 & 6 & 7 \\ a & t & t & a & c & k & p \\ o & s & t & p & o & n & e \\ d & u & n & t & i & l & t \\ w & o & a & m & x & x & x \end{pmatrix} = attackpostponeduntiltwoamxxx$

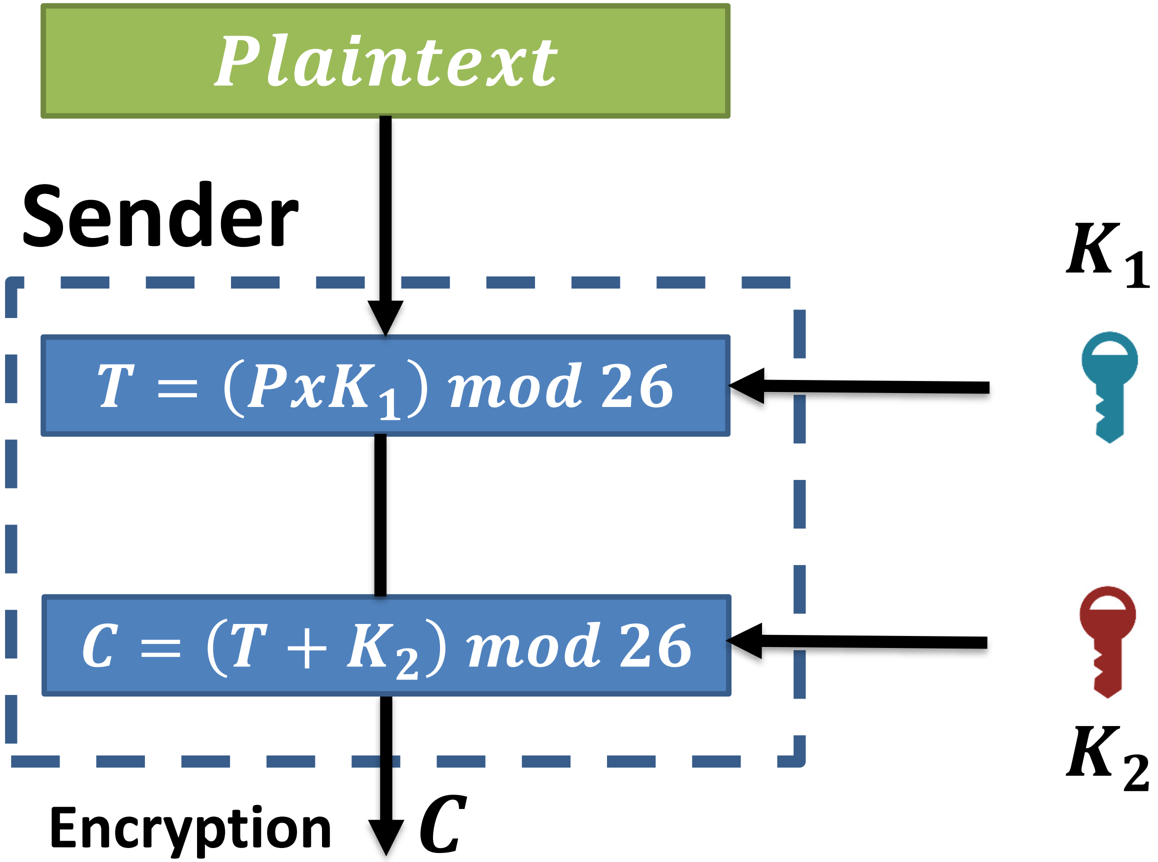
Task1

- ❑ As shown in Figure below, use Multiplicative Cipher to encrypt "enemy attack tonight" with key = 4.



Task2

❑ As shown in Figure below, use Affine Cipher to encrypt “enemy attack tonight” with key pair (4,3).



Plaintext
Sender
$T = (PxK_1)\ mod\ 26$
$C = (T + K_2)\ mod\ 26$
K_1
K_2
Encryption
C