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FILE OR SERIAL NUMBER AND SUBJECT

From File of Special Consultant (Friedman)
Course in Military Cryptanalysis, Part I Lessons 1, 2, 3 & 4

TO

NAME AND EXTENSION OF PERSON REQUESTING FILE: Mr. William Friedman LI6-8520

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NATIONAL SECURITY AGENCY

COURSE

IN

MILITARY CRYPTANALYSIS, PART I

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National Security Agency
Washington 25, D. C.

December 1952

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COURSE IN MILITARY CRYPTANALYSIS, PART I

Monoalphabetic Substitution Systems

Introduction

This is the first of a series of six basic courses in the art of military cryptanalysis. The purpose of this course is to impart to the student the methods and techniques which form the basis for the cryptanalysis of the simple types of military cipher systems. An understanding of these principles is necessary to grasp the more advanced cryptanalytic techniques employed in the attack on the complex cryptosystems which constitute present-day military cryptography.

The scope of this course is: fundamental principles; uniliteral substitution; multiliteral substitution; polygraphic substitution; and miscellaneous monoalphabetic substitution systems. It consists of ten lessons and an examination as follows:

Lesson 1, Fundamental principles

Lesson 2, Uniliteral substitution with standard and mixed cipher alphabets

Lesson 3, Multiliteral substitution: miscellaneous matrices; Baconian and Trithemius systems; elementary Baudot systems

Lesson 4, Multiliteral substitution with variants

Lesson 5, Polygraphic substitution: small matrices

Lesson 6, Polygraphic substitution: quadricular tables

Lesson 7, Polygraphic substitution: miscellaneous systems

Lesson 8, Miscellaneous monoalphabetic substitution systems; concealment systems

Lesson 9, Monoalphabetic substitution with irregular-length cipher units: monome-dinome systems; miscellaneous systems

Lesson 10, Syllabary squares and code charts

Examination

The text reference for this course is the National Security Agency publication, "Military Cryptanalysis, Part I" (December 1952).

This course has been designed as a self-study or extension-type course; therefore, there is no limit placed on the number of hours that may be spent in the completion of the course, any lesson, or the examination. However, for statistical purposes it is requested that the student indicate the number of hours spent in the completion of each lesson and the examination.

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The cryptograms in this course have for the most part been arranged in proper worksheet form, obviating the necessity of recopying; and frequency distributions have been given to reduce the amount of time spent on the purely clerical labor incidental to the solution. The underlying texts of the cryptograms comprise hypothetical ground, naval, air, and general administrative messages. Where necessary for solution, the specific nature of the text of any particular cryptogram is indicated. Otherwise, the text of a message may be assumed to be general administrative or ground text.

The only materials required are cross-section paper of $\frac{1}{4}$-inch squares, and a set of printed and blank alphabet strips. An eraser is of the utmost importance.

Special Instructions

So far as is practicable, detailed work sheets which usually form a part of the solution should be submitted with the solutions. In all the lessons of this course, it is required that the student recover all cipher alphabets, cipher tables, and specific keys used. He will also be required to state the method of operation of each cryptosystem and give the key words upon which each component is based.

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NATIONAL SECURITY AGENCY
Washington 25, D. C.

COURSE	Military Cryptanalysis, Part I
LESSON 1	Fundamental principles
TEXT ASSIGNMENT	Sections I-IV, inclusive.

1. a. What four things were thought by Captain Hitt to be essential to cryptanalytic success?

b. What six additional elements are also highly desirable?

2. a. Define the terms "cryptology", "cryptography", and "cryptanalysis."

b. What are the essential differences between substitution and transposition?

c. Differentiate between a code and a cipher system.

d. Explain the difference between the terms "general system" and "specific key".

e. Distinguish between monoalphabetic and polyalphabetic substitution.

3. What four fundamental operations are involved in the solution of practically every cryptogram?

4. In the solution of cryptograms involving a form of substitution, to what simple terms is it necessary to reduce them in order to reach a solution?

5. Is it always necessary to determine the specific key in order to reconstruct the plain text? Explain.

6. Indicate the language in which you would expect the plain text of the encrypted portion of the following message to be written. Give reasons for your answer.

From: João Fialho, São Paulo, Brasil.
To: Gualterio Costa, New York City.

Com referência ao seu telegrama. NSM NRJPN INJ PMVCOCEN VNPSN PMBMPCEN QMT JBCVCJ IJUM DTGAJ ITMCPN KPJUCEMIVCNP PMHMQQN UMIVCHMISJQ SMPVMCPJ SPCHMQSPM.

7. a. The letter E represents what percentage (in round numbers) of the letters in English telegraphic text?

b. What are the four most frequent consonants in English telegraphic text?

c. What are the five letters of lowest frequency in English telegraphic text?

d. What are the four most frequent digraphs in English telegraphic text?

e. Account for the discrepancies between frequencies of letters in English literary text and English telegraphic text.

8. What three facts can be determined from a study of the uniliteral frequency distribution?

9. In the following extract from a speech given during World War II, each dash indicates the omission of a letter. Complete the text by writing the necessary letters over each dash to form appropriate words.

"Washington's Birthday is e most a p _ _ _ _ _ _ _ _ _ occasion for us to talk with each _ _ _ _ _ about things as they are _ _ _ _ _ and things as we _ _ _ _ they shall be in the _ _ _ _ _ _.

"For _ _ _ _ t years, General Washington and his _ _ _ _ _ _ _ _ _ Army were faced c o _ _ _ _ _ _ _ _ _ _ with formidable _ _ _ _ and recurring _ _ _ _ _ _ _. _ _ _ _ _ _ _ _ and equipment were lacking. In a _ _ _ _ _, every winter was a Valley Forge. Throughout the _ _ _ _ _ _ _ _ states there existed selfish men, jealous men, _ _ _ _ _ u l men, who _ _ _ _ _ _ _ _ _ _ that Washington's _ _ _ _ _ was hopeless, that he should ask for a n _ _ _ _ _ _ _ _ peace.

"Washington's _ _ _ _ _ _ _ in those hard _ _ _ _ _ has provided the _ _ _ _ _ for all Americans ever since--a model of moral _ _ _ a. He held to his _ _ _ _ _ _, as it had been charted in the Declaration of Independence. He and the _ _ _ _ _ men who _ _ _ _ _ with him knew that no man's life or _ _ _ _ _ _ was secure, without freedom and free i _ _ _ _ _ _ _ _ n s.

"The present _ _ _ _ _ struggle has _ _ _ _ _ us increasingly that _ _ _ _ o m of person and _ _ _ _ _ _ _ y of property anywhere in the _ _ _ _ depend upon the security of the rights and obligations of liberty and _ _ _ _ _ _ everywhere in the world.

"This war is a new _ _ _ _ of war. It is _ _ _ _ _ _ _ from all other wars of the _ _ _ _, not only in its methods and

_ _ _ _ _ _ _ but also in its geography. It is warfare in terms of every c o n _ _ _ _ _ _, every _ _ _ _ n d, every sea, and every a _ _ - _ _ n e in the world. The _ _ _ _ _ oceans which have been h e r _ _ _ _ _ in the past as our _ _ _ _ _ _ _ _ _ _ from attack have become _ _ _ _ _ s s battlefields on which we are _ _ _ - _ _ _ _ _ _ being challenged by our enemies."

10. a. In the following examples the words of sentences have been transposed. Rearrange the words to make plain text.

(1) AT NOTHING REPORT THIS TIME TO

(2) ARTILLERY SECTOR BARRAGE NORTHWEST HEAVY IN

b. In the following examples the letters of several words of each sentence have been transposed. Rearrange the letters to make good words that will give intelligible plain text.

(1) Eight SESTYODRER have DTPADERE to join SAKT REOFC

(2) ABELNU to contact ATTAINBLO on my right AFKLN

c. In the following examples the words of each sentence have been transposed and, in the case of several words, the letters have also been transposed. Reconstruct the plain text.

(1) OLANG RIDGE TANK GIMNOV EHOTISL EAST NOMLCU

(2) DOWN MEYEN OFANERTON SIX THIS OTHS SNEALP

d. In the following examples, the letters of each word of each sentence have been rearranged in the order in which they appear in the normal alphabet. Reconstruct the plain text.

(1) ADELY AACKTT CDDEEHLSU OT CCEEMMNO AT EGHIT HIST GIMNNOR

(2) ADEEIIILMMTY NOPU CEEIPRT ADHIRTWW OT AADEEGNPRRR IINOOPST

e. In the following examples the plain text has been broken up into groups of five letters and then in each group of five the letters have been rearranged in the order in which they appear in the normal alphabet. Reconstruct the plain text.

(1) ORSUU ABIMR AEHNS ENSUV ADKOR ADEGM EEINN EMNVY EELSS S

(2) AEIRR ACNNO AINSS ACEPT ELORR OPRST AILRT EELRY ACIMP EEMNT DESST DEORY

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11. Using cross-section paper prepare a uniliteral frequency bar distribution of the letters of the following paragraph:

"The shortest and surest way to live with honor in the world is to be in reality what we would appear to be; all human virtues increase and strengthen themselves by the practice and experience of them."

12. Determine the class to which the cipher systems, which were used in enciphering the following messages, belong:

a. O R A N A T H P N O S K T C D M E E E S C E R A E
R N U S A E T L G D A Y E C A

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

b. D H J J K Q O A H R X K S O F H P Q G A P P H L A
D I A D E H J R O A M A H Q A

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

c. R O L E H K B W F Z C Q C P Z N V J W Z M I V E Q
E P C I N O J S J U Y M W Q B

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

13. Which of the following substitution ciphers are monoalphabetic?

a. U J K L W E U V K L F S P A Q P H T K R D Z N G L
S E L Y N X Y X B X J D A T U W E U Z G W F V X M
M N Z A Y A O S G U D C L G I O E W J E I F O K M
K N W A P K O I E V A R O E V W S C W N S B C Y X

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

b. H U P Y P X X A E P A F G Z P V G L H A S L X H U
S X X A Y P W K A S L H P R H A L O B A X P L V S
W U P J P O B S H U H U P G F X G K P H P V S W U
P J O P Z S V P Y S M P O A X U L S L P C G N J X

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

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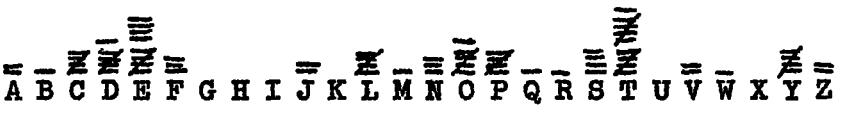
c. G X Y V L Z X M X S L O Z G R W E J L X P W T K Z
G M X L W Q I V Z W Q B R X K K T D V L M X A E X
V H M X A L O T L Y T K D W X G B Q K Q L W Z X G
R T Y Y Z K T O X G A W X L Q L O Z G R X V W G Q

14. The following messages were enciphered monoalphabetically. Determine in each case whether the cipher alphabet used was a standard or mixed alphabet and if standard, whether direct or reversed.

a. A N V O R L O U N Q R L E Z W Z H N E Z W Z B O R
Z K Y L F A O Z S O O N O R F P J Z P P L D Z D N
L R Z L B L A B W Z H N A P O W Q H O O R Z I Z U

b. E S P A P L V D L Y O E C Z F R S D T Y E S T D O
T D E C T M F E T Z Y B F T N V W J T O P Y E T Q
J T E L D O T C P N E D E L Y O L C O N T A S P C



c. P Y H Y L X O L W Y J J V Y X O I L Y R Y Q Y P J
K N Y L K Y H Y L C P A Y A C L Y X I R Q Y J V O
Z K O X C P C R E K U K U P J I U J U O P R I A S

15. Derive the ϕ_p, ϕ_r, ϕ_o, Λ_p, Λ_r, and Λ_o for each of the following distributions, and evaluate the /monoalphabetic/ goodness of ϕ_o and Λ_o of each in terms of "good", "fair", or "poor", entering these data in the attached diagram. On the basis of the foregoing, decide which distributions are most probably monoalphabetic and which are most probably non-monoalphabetic, indicating your decision by a check (✓) in the diagram; in the case of those not clearly belonging in either of these categories, check "decision suspended".

a. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

b. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

c. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

d. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

e. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

f. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

g. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

h. A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

								Goodness of ϕ_o			Goodness of Λ_o			Decision		
	N	ϕ_p	ϕ_r	ϕ_o	Λ_p	Λ_r	Λ_o	G	F	P	G	F	P	mono.	non-mono.	susp.
a.																
b.																
c.																
d.																
e.																
f.																
g.																
h.																

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16. From the intercepted traffic of three intercept stations operating in the same sector of the front, the following code messages were selected for study by a member of the cryptanalytic section at GHQ. They are undoubtedly three versions of one enemy message, but there appears to be a number of differences, due no doubt to operating difficulties at the several stations. Study the messages and reconstruct from them the actual code text sent by the enemy station.

I. Time intercepted 1612 by HS W F F V L D C

GR 35 BT

NR 17 D Y B I E D U F T O A M E J A K I B O N
S G C O Y F O B A K D O D L A L U F Y D K A W A L
A P A Y N C O D A P K E D U R J O P I D J E N O X
M E H A Z L O G I S K U T E G E V A U K I P B E M
K E H Z A H O B W E A V D U Z F O F A _ E M C O Z
E G B L O D O F Y O E N C _ _ M A W E N _ _ _ _ _
_ _

II. Time intercepted 1610 by MR M F F V L D C

GR 35 BT

NR I_ D Y B I E B U F T O A M E J A K I B O N
I P K O _ F _ B A K D O D L A L U F Y L K A W A L
A P A Y N _ _ _ _ _ _ _ _ D U A _ _ P I D J E N O X
N E H A Z L O G I S K U T E G E V A U C I R B W
K E H Z A S O B W E V A D U Z F O F E T E M C O Z
E G B L O D O F Y O A E C D A M A W E N _ _ _ O M
E M C O Z A C F A H L O F I R 0 9 3 5

III. Time intercepted 1612 by YG W F F V L D K

GR _ _ BT

NR 17 D Y B I E D U F T O A M E J A K S B O N
I P C O Y _ _ _ A _ D O _ _ _ L U F Y L K A W A L
A P E T Y N C O D A P K E D U R W O P I D J E N O X
M E H A Z L O G H K U T E G E V A U K I P B E M
K E H Z A H O B W E A V D U Z F O F E T E M C O Z
E G B L O D O F Y O E N C O A M A W E N M A W E N
E X F O M E M C O Z A C F A H L O F I R 0 9 3 5

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NATIONAL SECURITY AGENCY
Washington 25, D. C.

COURSE	Military Cryptanalysis, Part I
LESSON 2	Uniliteral substitution with standard and mixed cipher alphabets
TEXT ASSIGNMENT	Sections V and VI

1. a. What is the first step one should take in attempting to solve an unknown cryptogram that is obviously a substitution cipher?

b. If this step is unsuccessful and the cryptogram is obviously monoalphabetic in character, what type of cipher alphabet may be assumed to have been used?

2. a. Name two methods of solving monoalphabetic substitution ciphers involving standard cipher alphabets.

b. In the solution of a substitution cipher by completing the plain component sequence involving reversed standard alphabets, what are the successive steps?

c. Why do monoalphabetic cryptograms involving standard cipher alphabets yield such a low degree of cryptosecurity?

3. What are four characteristics of vowels which permit their classification as such in monoalphabetic substitution ciphers involving mixed cipher alphabets?

4. a. What two places in every message lend themselves more readily to successful attack by the assumption of words than do any other places? Explain.

b. What is meant by the "probable word method" of solution?

5. a. What is meant by the word pattern "A B C B A D B"?

b. For each pattern given below, indicate one good English word that contains the pattern:

(1) A B C B A D B

(2) A A B A

(3) A B C D A

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6. Solve the following cryptogram and indicate the specific key ($A_p=\theta_c$):

J M Q V S Q Z X I F F M Z S L I Z M L Z C E M E B

F Q O M E M D X Y Q O Z C Y Y X J M Z I V M Z I Y

O Q W Y I D K Y M V M Z M N Q E Q K M X C C W Z B

C Y I X I C D Y Y X C B Z Q I F Z C Q N H W D O X

I C D J Q Y P M M D Y M V M Z M F S N Q E Q K M N

Q D N E W O J M A W I B E M D X N M Y X Z C S M N

Y X C B U M Q Z M E C V I D K C W Z X Z C C B Y X

C Z M Q Z B C Y I X I C D Y Y X C B Z Q F Y X C D

ϕ_p=2655 ϕ_r=1531 ϕ_o=2636

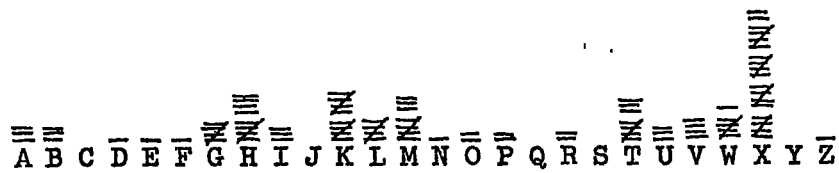
7. Solve the following cryptogram, and indicate the specific key:

W X L M K H R X K L A T O X U X X G H K W X K X W

M H I K H V X X W T M H G V X M H T K X T P A X K

X L N U F T K B G X T V M B O B M R A T L U X X G

K X I H K M X W L M H I T V D G H P E X W Z X X X



ϕ_p=660 ϕ_r=381 ϕ_o=848

8. Solve the following cryptograms, and indicate the specific keys:

a. Q H H Y L Y D W Q J J M E F C

b. Y X S E D Y F S X U H W X U S

9. The following badly garbled cryptogram was intercepted. Reconstruct the original plaintext message, resolving the errors and omissions, and indicate the specific key:

H U V S H U D S U - E K H C U I E Q W U D K - R U

H O X H U U U Y M X J I U - U D T Q J U T E D U A

Y N T U S - - - - - I J E F Y D I J K H S J Y E -

I O Q L U R U U N Y I I K U - J E Q B D I K R H E

T Y D Q J - S E C C Q - T I J E Y D Y W Y Q J U K

D Y J J H Q Y D C D W F H E W H Q K I K D T U H J

X A F H E R Y I Y E D I E V F Q H Q M H Q U X J -

E E V - F - S Y Q B T H T U H I D M C R U H I Y T

ϕ_p=2270 ϕ_r=1311 ϕ_o=2136

10. a. Construct a triliteral frequency distribution showing one prefix and one suffix of the letters of the cryptogram below. On the work sheet below, indicate by underscoring in black all repetitions of three or more letters. Other significant details may be marked in different colors.

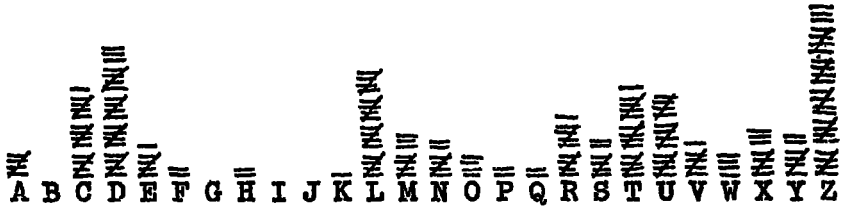
b. Prepare a condensed table of repetitions of digraphs and trigraphs appearing more than twice, and include all repetitions of longer polygraphs.

c. Using the data obtained in a and b above, complete the solution of the cryptogram, and recover all keys.

	5	10	15	20	25
A	U B S Y B	V X R P N	C G U M Z	X G P N P	C U B Q P
B	U X X F Z	X B N B M	I G V R P	N V X U Y	R X G N D
C	F B Z H I	Z U X G L	L B U I B	M Q L Z R	B M B N X
D	V G N O P	P A B A Z	U B Z P N	B C G H B	M G L B V
E	N P U X F	B Z V X P	C D U B B	N H G L L	B V X P Q
F	Q F P X P	D U Z Q F	G R U B R	P N N Z G	V V Z N R
G	B M G V V	G P N V N	B D Z X G	H B E B R	Z Y V B P
H	C Z A H B	U V B O B	Z X F B U	R P N A G	X G P N V

11. Solve the cryptogram below, suspected to contain the probable word "BLOCKADE"; recover all keys.

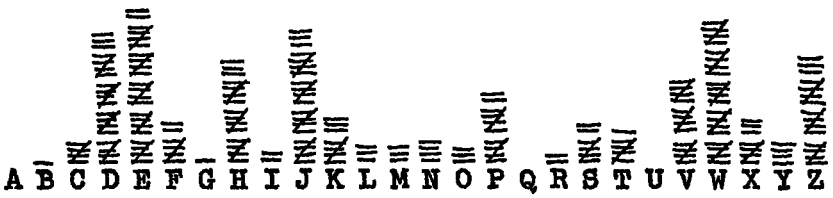
	5					10					15					20					25
A	L	C	T	C	E	L	U	Z	O	D	U	C	R	E	A	W	Z	U	S	N	F	Z	X	D	Y
B	D	R	T	L	D	S	D	R	Z	S	D	E	U	C	M	U	Z	Z	K	Z	U	D	C	D	V
C	T	Q	T	X	D	A	O	Y	Z	C	Z	W	Y	D	X	P	T	V	Z	D	S	C	M	Z	Z
D	R	Z	A	Q	L	L	D	E	C	M	Z	U	R	X	D	T	L	C	M	T	L	W	Z	Z	R
E	Z	S	S	Z	X	C	Z	V	L	C	D	O	U	D	X	P	Z	C	W	T	U	U	T	H	Z
F	S	U	D	A	D	E	U	F	Z	L	L	Z	Y	L	X	D	R	C	N	R	E	Z	L	C	D
G	M	T	U	T	L	L	M	D	L	C	N	Y	Z	L	M	D	U	Z	O	D	L	N	C	N	D
H	R	L	T	R	V	M	T	L	V	T	A	T	H	Z	V	U	T	N	Y	Y	N	R	Z	L	X



ϕ_P=2655 ϕ_T=1532 ϕ_O=2770

12. Solve the following cryptogram, and recover all keys:

	5	10	15	20	25
A	J Z D F V	W H E D Z	V H W D S	Y K T W D	O E D Z D
B	E D S E C	C W H H W	E D Z T E	X X W S Z	V N Z V Z
C	S P F J K	V Z T Y P	H J D W O	L J W D P	V P W T I
D	R E D Z E	X E K V F	P J V E Y	H H J E F	E D Z F V
E	W H E D Z	V H J P J	Z H J L P	J X E K V	J L T W M
F	W H W E D	W H W D M	W S W D W	J R E X I	Y K Z C E
G	K D J P W	D C E M W	D O N Z H	J J E P J	J P S B E
H	K V F E H	W J W E D	H N Z H J	E X X P W	V J E N D
J	H J E F S	E D X W V	C P J W E	D V Z G K	Z H J Z T



ϕ_p=3362 ϕ_r=1940 ϕ_o=3560

13. Using the sequences recovered in Problem 12, solve the following cryptograms and indicate the specific keys:

a. U R J J R X Q U Q X K S A R B B E T O I

$\bar{A}\ \bar{\bar{B}}\ C\ D\ \bar{E}\ F\ G\ H\ \bar{I}\ \bar{\bar{J}}\ \bar{K}\ L\ M\ N\ \bar{O}\ P\ \bar{\bar{Q}}\ \bar{\bar{R}}\ \bar{S}\ \bar{T}\ \bar{\bar{U}}\ V\ W\ \bar{\bar{X}}\ Y\ Z$

$\phi_p=25 \quad \phi_r=15 \quad \phi_o=16$

b. F D L D Y X Z U M U E U F P N D V O F E A L Y R W

U M L J X A F D Y E X E K Q P D O Y C V R E U A X

$\bar{\bar{A}}\ B\ \bar{C}\ \bar{\bar{\bar{D}}}\ \bar{\bar{\bar{E}}}\ \bar{\bar{F}}\ G\ H\ I\ \bar{J}\ \bar{K}\ \bar{\bar{L}}\ \bar{\bar{M}}\ \bar{N}\ \bar{\bar{O}}\ \bar{\bar{P}}\ \bar{Q}\ \bar{\bar{R}}\ S\ T\ \bar{\bar{\bar{U}}}\ \bar{\bar{V}}\ \bar{W}\ \bar{\bar{\bar{X}}}\ \bar{\bar{Y}}\ \bar{Z}$

$\phi_p=163 \quad \phi_r=94 \quad \phi_o=118$

14. The following cryptograms, enciphered with random cipher alphabets, are in bona fide word lengths. Solve them.

a. H Y A R V J Z G H A R O T V K C G K M M G K H Z M L K U G

L K U G O R O E H O Z E M V H F S R M J R O T

J E H Z P U H G V E G M R O M C J K K S J K U M E

b. R G R Q R U T D S P Y U R D P Z F T A V D R C A Y C F O

J O D R Z Y U U F S P P F U Z R T F A D Y G P

c. C D G W D S A L C A U M M D C R B U C D Y V D V D J R

I Y S U A U Y V S L Z C Y S S C U T D C

15. In solving several unrelated monoalphabetic cryptograms, the following cipher alphabets were reconstructed. Recover all key words in each case. To facilitate solution, significant segments have been underlined.

a.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: N L W P F R T H S Y D Q A K V E B M X G C O Z I J U

b.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: Z Q X P E O N M W L K J H G F D B V Y U T R I C S A

c.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: P Q E R V M O Z W U T H A X B C D F S Y G I J K L N

d.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: A U Z J T X H S W G R M B N O C I Q F E K Y P D V L

e.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: C K V E B O Y F D P Z G Q H S I T L W N J U R A M X

f.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: L M C P O Q I J H R S N T B D E U G V K A W X Y F Z

g.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: C D G P V Z K H Q L A E I J N S W U B F M O T X Y R

h.

P: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
C: L B E K D G R M F A X S N H C Z T O I Y U P J V Q W

REF ID:A64639

NATIONAL SECURITY AGENCY
Washington 25, D. C.

COURSE — Military Cryptanalysis, Part I

LESSON 3 — Multiliteral substitution with single-equivalent cipher alphabets

TEXT ASSIGNMENT — Section VII

1. Solve the following cryptogram, and recover all keys:

					5					10					15
A	DT	LR	WE	OE	OE	WH	RR	WR	LA	WH	WA	DE	DA	WR	LE
B	LE	OR	RE	WT	OR	WA	OH	WH	OR	LE	LR	WA	RR	RR	WH
C	WA	WH	OE	OR	LE	LE	WR	WA	WH	OH	LR	LE	LR	WA	OH
D	OE	LR	OA	OA	OE	LR	OR	RE	OA	OA	WH	WT	WH	WA	WA
E	WR	WA	WH	DE	RT	OE	WH	WH	RE	OR	OA	RT	OE	LR	OR
F	RE	WR	WE	WA	OH	DE	WR	LR	WA	WA	WR	WA	WH	DE	DA
G	LR	LR	WA	WH	OA	DE	LR	LT	LT	LR	OA	WR	DE	WR	LR
H	WA	OA	LR	RA	RA	LR	WE	OE	DE	RT	OE	WH	RR	WR	LA
J	WH	WA	DE	DA	WR	LE	LE	OT	WH	OE	WH	WH	WA	RA	LR
K	OE	OH	WH	RE	OT	DT	OR	RE	RE	WR	DE	WR	LR	WA	OR
L	LE	OR	OE	DE	WR	LE	LE	WH	OE	DT	OA	WE	LT	LT	LR
M	OE	DE	OA	DE	LR	LT	OH	LR	LE	LR	WA	WH	LE	OT	WH
N	WA	WA	WR	WA	RR										

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	A	E	H	R	T
D	3	12	–	–	3
L	2	13	–	21	5
O	10	14	6	10	3
R	3	7	–	5	3
W	22	4	22	13	2

ϕ_p=2270 ϕ_r=1362 ϕ_o=2288

(25-element alphabet)

2. This message was sent by the Fifteenth Infantry. Solve it and recover all keys:

	5					10								15
A	CY	AO	NX	CN	NO	CN	AO	AO	OG	ON	NG	BY	OX	OX	RO
B	CG	NY	RO	AN	RE	AG	RO	OX	AO	AN	AX	AX	AG	AN	AG
C	CN	RO	OX	OX	BY	AN	AG	CN	BE	CX	BN	BX	CG	RO	ON
D	CO	RE	CN	AY	BG	CE	ON	NO	AO	OG	RO	NO	NO	RO	RE
E	OO	NG	BY	OX	OX	RY	AG	AX	BY	AN	OG	CN	AO	OY	OG
F	NO	OX	CY	NX	OG	AO	AN	CN	AG	RE	AG	BY	OG	NO	AO
G	BO	AO	CN	CG	AG	CN	ON	BO	CN	AO	OY	CO	OE	ON	NO
H	AO	OG	RO	NO	NG	RO	NO	AG	CN	RE	AO	OX	RX	AE	BY
J	AN	BO													

	E	G	N	O	X	Y
A	1	9	7	12	3	1
B	1	1	1	3	1	6
C	1	3	11	2	1	2
N	–	3	–	9	2	1
O	1	7	5	1	9	2
R	5	–	–	9	1	1

ϕ_p=960 (approx.) ϕ_r=410 ϕ_o=716

(36-element alphabet)

3. Solve the following cryptogram, and recover all keys:

	5						10						15		
A	RG	GP	EE	GR	RG	GP	ES	GR	RG	PP	GE	PR	GE	RG	GS
B	AS	GR	RR	GS	AE	PP	GP	GA	PP	RA	EA	ES	GR	RG	PP
C	GE	RA	PR	GS	RE	GP	AR	GP	GS	PP	GP	RG	RA	EA	PP
D	PS	PG	AR	PE	GA	RR	RG	GP	RR	RE	PG	PP	RA	EA	RS
E	PG	PE	RG	AR	PE	GA	RR	RG	GP	RR	RP	AE	GS	GA	AP
F	GP	PP	RA	EP	ES	GP	RA	GP	RA	PE	PR	PR	AE	GR	GP
G	RA	GA	GP	GP	RR	GP	RR	GR	AS	AS	GP	RR	GR	GS	PP
H	GP	AE	GE	RS	PG	RG	GS	RE	PP	GR	GG	GS	PP	GR	PG
J	GA	PG	RS	RE	PG	AS	PR	GS	GA	GE	RR	EA	ES	GR	RG
K	RR	RP	GS	PP	PP	GS	AE	GR	PG	GA	EP	RG	GP	EE	GR
L	RA	GR	PP	GR	PG	GA	AR	GS	RA	RP	GP	GP	GA	GS	PE
M	ES	PG	RG	GR	ER	GP	RR	RP	GE	RG	GP	AG	GR	AS	GP
N	GA	PP	GS	AE	AR	PA	EP	RG	GP	PR	AE	GE	RG	GP	EE
P	GP	RA	PP	GP	RR										

	A	E	G	P	R	S
A	–	7	1	1	5	5
E	4	3	–	3	1	5
G	11	7	1	27	16	14
P	1	5	10	16	6	1
R	11	4	16	4	12	3

ϕ_p=2260 (approx.) ϕ_r=1164 ϕ_o=2294

(30-element alphabet)

4. Solve the following cryptogram, and recover all keys:

	5								10
A	AAC	AAB	BBA	AAB	AAC	AAB	ABB	ACC	AAB	CCA
B	ABA	ABC	AAC	CAA	AAB	BAA	BAA	AAA	BBB	AAB
C	ABB	ABC	CAA	BAB	AAB	AAC	BBA	ACB	CBA	AAB
D	BBA	BCC	ACB	BBB	BBC	ACA	BBA	ABA	ABC	AAC
E	ACA	BBC	AAC	AAB	AAB	BBC	AAA	BAA	BAB	AAB
F	AAB	ABB	ACC	AAA	ABB	ACC	AAB	BCC	BCC	AAB
G	BAC	CCC	ABB	AAB	CBC	ACA	ACA	AAC	ACB	CAB
H	AAA	ACA	CCB	AAB	AAC	ABA	BAA	ACB	CBC	CCB
J	AAB	AAC	ABA	CCB	AAB	AAC	ABA			

	2:	A	A	A	B	B	B	C	C	C
	3:	A	B	C	A	B	C	A	B	C
	A	4	18	10	5	5	3	5	4	3
1:	B	4	2	1	4	2	3	-	-	3
	C	2	1	-	1	-	2	1	3	1

ϕ_p=499 ϕ_r=277 ϕ_o=542

(27-element alphabet)

5. Solve the following naval message, and recover all keys:

11101	10333	12231	03023	33122	31000
06002	60610	15231	40424	24052	33206
03042	61122	33263	12334	11052	33011
00001	12200	20010	02600	06151	62611
13367	89310	62222	26050	41221	04101
30511	24230	52604	22221	21604	10151
10023	14122	30105	00113	50024	11111
33504	10131	42305	03042	60623	10360

6. Solve the following cryptogram, and recover all keys:

45264 56282 02523 29276 16145 23820
63216 52729 27212 60652 16729 47694
56529 02146 04161 25424 90692 12143
65026 45672 92325 61272 84543 04182
04221 67262 94523 41252 92945 23820
46272 34506 52921 63023 45646 74565
29082 21670 23456 12582 02947 27650
29210 23472 12543 65000

7. Solve the following cryptogram, and recover all keys:

05105 23804 91161 38349 22702 74491
16138 33834 92274 27505 31612 74492
16127 14914 92274 38216 12724 91161
27138 10523 84274 05405 23801 61491
16105 22713 80271 05227 44910 51052
05327 14921 60491 05227 10502 74163
38016 11653 85492 27405 20531 61494
49238 42713 82492 27427 20522 71380
49127 02714 91270 49149 12702 72273
05505 30522 74272 16127 13814 93052
49449 24910 52380 05149 23834 91492
27449 23823 82384 38105 23844 91050

8. The following is a text in the Baudot teleprinter code enciphered by a simple machine employing five two-position switches which operate polarized relays. Each switch has the function of changing the polarity of its respective baud (a single "mark" or "space" impulse), if the switch is in the 'active' position. If the switch is in the 'inactive' position, the polarity of the baud is unaffected. The switch settings remain constant for each message. As an example, if switches 1 and 4 are active (x), and 2, 3 and 5 are inactive (o), then the word ENEMY is enciphered thus:

Key:	xooxo	xooxo	xooxo	xooxo	xooxo
Plain:	+----	--++-	+----	--+++	+-+-+
Cipher:	---+-	+-+--	---+-	+-+-+	--+++

Solve the message and recover the switch settings.

	1	2	3	4	5	6	7	8	9	10
A	+-+--	+-++-	+---+	++-++	++++-	+---+	-+++-	-+---	-----	-+-+-
B	+-+--	+----	+---+	--+++	++--+	++-+-	+-+++	+++-+	+++-+	--+++
C	++--+	+++++	--+-+	++-++	+-+--	+---+	-++-+	+++++	+-+--	++--+
D	+++--	+++--	--+-+	+++++	-----	+---+	---++	++--+	+++++	--+-+
E	+---+	+-++-	+--++	+---+	+--++	--+-+	-++--	+-+--	+-++-	+--++
F	+---+	-+++-	-+-++	++--+	-++--	++---	-++-+	-+--+	+-++-	-----
G	+++--	+--+-	-+-+-	+++-+	+++-+	+---+	+---+	-++-+	+-+--	-++--
H	-++-+	+-+--'	--+-+	+++++	+---+	++-++	+-++-	+++--	+---+	-+++-
J	-+---	+-+--	-+-+-	+---+	++--+	+--++	---++			

3:	+	+	+	+	-	-	-	-
4:	+	+	-	-	+	+	-	-
5:	+	-	+	-	+	-	+	-

1,2:

++	5	1	4	4	3	1	6	1
+-	1	5	-	8	4	1	13	1
-+	-	3	4	3	1	3	1	2
--	2	-	5	-	2	-	-	3

ϕ_p=480 (approx.) ϕ_r=234 ϕ_o=386

(32-element alphabet)

REF ID:A64639

NATIONAL SECURITY AGENCY
Washington 25, D. C.

COURSE	Military Cryptanalysis, Part I
LESSON 4	Multiliteral substitution with variants
TEXT ASSIGNMENT	Section VIII

1. Solve the following cryptogram, and recover all keys:

	5				10						15			
A	RA	DE	KE	PE	VE	TI	BO	LA	GO	DU	JO	BE	KI	BI	JO
B	BU	JA	VA	ME	LA	BE	KI	RE	FE	DO	VI	JO	SA	DO	JE
C	KI	BA	MO	SA	CU	GE	GE	PI	BO	KI	JU	CE	CI	MI	NE
D	PO	JU	CE	RE	NA	BU	BE	KO	RA	DE	KE	TE	SE	TI	JO
E	FA	GO	DU	DO	JE	KI	DI	JO	BU	JA	CE	BO	FO	BA	BU
F	DA	LE	JO	NI	DO	NA	BO	BE	PI	GI	ME	TE	CO	JO	TI
G	SA	BO	TI	DU	MO	FA	BU	NA	DU	DE	TO	GI	BE	SE	BU
H	GE	CO	PA	TA	KE	CE	NA	VA	MO	LO	ME	NA	DU	DE	CE
J	BO	FO	DA	DU	DA	LE	BO	SI	JO	VA	DO	DE	TI	NI	DO
K	CO	FI	DE	VE	CI	BU	DA	LE	BO	VI	DO	NA	JO	BE	KI
L	VA	DU	DE	KO	GO	RE	MO	PE	SA	RA	JE	KA	DO	PI	RI

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2. Solve the following cryptogram, and recover all keys:

					5					10					15
A	DR	DD	SY	DA	RA	RR	SB	YA	BT	TY	AR	HI	DB	TB	AD
B	YY	YB	SA	AA	HI	DA	TD	HR	YB	TD	RB	RI	AI	HH	BT
C	DD	IA	AI	BB	HA	YD	TH	YA	HI	BA	YT	YD	YY	BD	YH
D	SD	DI	SB	AA	ST	YD	RH	SD	SR	YR	DT	SR	RA	RR	YB
E	SA	BT	TY	HR	AI	DB	IB	AD	DY	YB	SA	HA	HI	DA	TD
F	TS	DB	SH	YH	DI	SD	TT	TT	YY	HH	ST	YI	SB	AA	ST
G	DD	AH	DH	YT	RH	HI	ID	AR	SB	BA	RI	HB	AI	HI	RH
H	DB	SH	HA	RI	DA	AI	IB	YB	DI	SI	DD	YA	BB	YT	HH
J	II	YH	TY	BS	DD	YR	SR	RI	HH	TD	DT	TA	AI	RY	ST
K	SH	DH	AB	AI	TI	YT	AH	HY	AR	AI	RH	DI	YD	DD	YA
L	TB	DT	HH	SB	AA	DT	DD	RH	YD	DR	YB	DH	SH	SR	DD
M	DA	SI	RI	ID	ST	BD	SI	SD	TT	BH	SH	RI	AA	HI	BB
N	IS	BI	HI	RH	AY	DB	BA	AI	DH	SH					

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3. Solve the following cryptogram, and recover all keys:

					5					10					15
A	99	18	57	82	12	28	78	90	25	04	15	30	04	06	14
B	57	34	64	20	72	15	30	02	57	44	84	52	66	11	81
C	87	58	35	78	31	14	70	90	68	47	30	13	15	21	86
D	92	43	10	30	35	20	31	32	64	18	57	26	84	12	06
E	34	25	69	72	90	78	07	90	31	29	57	50	82	19	53
F	31	72	51	36	10	86	36	47	18	67	26	04	92	82	30
G	08	31	58	90	88	87	91	10	20	82	31	14	56	57	31
H	88	04	31	30	66	47	30	36	18	99	20	06	97	31	21
J	55	99	18	20	10	28	74	68	90	41	69	82	90	78	31
K	86	88	15	91	26	92	72	87	14	43	20	53	28	64	92
L	47	02	58	35	10	96	05	34	37	85	06	26	80	50	92
M	68	10	70	81	92	18	02	86	49	47	07	82	94	06	69
N	15	21	90	56	10	40	01	68	90	15	35	57	52	32	60
P	47	64	36	71	06	55	00	68	78	45	52	12	69	43	

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4. This message is suspected of having an ending similar to Problem 3. Solve it and recover all keys:

	5					10							15
A	22	08	71	29	19	83	05	34	76	58	05	56	62	26	22
B	35	48	75	13	78	58	34	65	02	07	71	51	87	35	96
C	10	32	69	45	47	81	46	11	01	14	67	37	75	79	35
D	30	53	29	37	46	60	19	30	94	66	49	68	88	57	98
E	84	93	30	86	28	90	51	04	53	03	84	76	58	31	57
F	42	12	86	49	36	79	54	26	09	38	24	41	86	63	79
G	08	28	67	68	66	94	22	63	71	66	83	56	05	07	58
H	95	60	19	62	26	48	23	59	40	38	15	67	43	92	42
J	62	77	43	79	54	69	38	65	16	82	10	96	67	97	57
K	48	93	24	13	53	29	46	37	32	65	12	94	84	95	68
L	83	93	98	37	75	79	45	12	97	84	53	03	75	76	95
M	31	29	32	21	49	17	25	73	00	69	86	36	79	45	19
N	77	98	38	95	97	93	94	98	72	42	59	00	08	50	44
P	27	26	62	57	06	91	23								

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FREQUENCY DISTRIBUTIONS

	A	E	I	O	U
B	2	6	1	8	7
C	-	5	2	3	1
D	4	6	1	8	7
F	2	1	1	2	-
G	-	3	2	3	-
J	2	3	-	9	2
K	1	3	6	2	-
L	2	3	-	1	-
M	-	3	1	4	-
N	6	1	2	-	-
P	1	2	3	1	-
R	3	3	1	-	-
S	4	2	1	-	-
T	1	2	5	1	-
V	4	2	2	-	-

Problem 1

	A	B	D	H	I	R	S	T	Y
A	5	1	2	2	9	3	-	-	1
B	3	3	2	1	1	-	1	3	-
D	5	5	8	4	4	2	-	4	1
H	3	1	-	5	8	2	-	-	1
I	1	3	1	-	1	-	1	-	-
R	2	1	-	6	6	2	-	-	1
S	3	5	4	6	3	4	-	5	1
T	1	2	4	1	1	-	1	3	3
Y	4	6	5	3	1	2	-	4	3

Problem 2

	0	1	2	3	4	5	6	7	8	9
0	1	1	3	-	4	1	6	2	1	-
1	7	1	3	1	4	6	-	-	6	1
2	6	3	-	-	-	2	4	-	3	1
3	7	10	2	-	3	4	4	1	-	-
4	1	1	-	3	1	1	-	6	-	1
5	2	1	3	2	-	2	2	7	3	-
6	1	-	-	-	4	-	2	1	5	4
7	2	1	4	-	1	-	-	-	5	-
8	1	2	6	-	2	1	4	3	3	-
9	9	2	6	-	1	-	1	1	-	3

Problem 3

	0	1	2	3	4	5	6	7	8	9
0	2	1	1	2	1	3	1	2	3	1
1	2	1	3	2	1	1	1	1	-	4
2	-	1	3	2	2	1	3	1	3	4
3	3	2	3	-	2	3	2	4	4	-
4	1	1	3	2	1	3	3	1	3	3
5	1	2	-	4	2	-	2	4	4	2
6	2	-	4	2	-	3	3	4	3	3
7	-	3	1	1	-	4	3	2	1	6
8	-	1	1	3	4	-	4	1	1	-
9	1	1	1	4	4	4	2	3	4	-

Problem 4

5. Solve the following cryptogram, and recover all keys:

80713 06941 35696 80213 28061 37695
69680 91394 78800 25513 28096 91134
47713 68026 97695 13913 72502 56475
80280 88091 35802 25247 31341 39696
25525 12508 09132 47825 81314 74256
69525 51301 36477 13169 46966 90699
80247 46951 30801 80525 11378 04470
69213 11308 03477

6. Solve the following cryptogram, and recover all keys:

18905 52131 89011 04414 52131 34022
05518 92022 35156 19005 52240 55145
19020 21561 67189 08815 60110 44190
08801 11900 22055 05514 54044 15460
35832 53583 14303 41532 53474 15459
46035 83813 14280 27946 04603 14448
51628 03143 58404 33637 04044 15291
37031 43036 73730 72971 87296 73684
70757 26957 30572 71872 97075 72550
57261 76847 29729 60661 77186 51572
71871 85385 94572

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7. Solve the following cryptogram, and recover all keys:

72109	19015	41776	04657	89925	96235
70368	62717	67091	83938	99294	88596
52368	62170	37091	22620	80735	96695
04627	17032	53136	77644	22537	12262
47907	38026	22703	88434	30196	04118
66826	27034	15596	84825	35230	46569
16375	84979	74893	10920	85780	73541
97477	67212	08479	35210	91365	78947
39865	97030	28334	15432	54516	59910
04639	82992	26541	09142	43430	28208
75852	33987	03712	25322	67217	58578

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8. The following cryptograms are suspected to be isologs. Solve them, and recover all keys:

Message "A"

09728	23144	33987	73514	27769	10677
94418	99479	41948	66432	24374	48499
56758	47636	35546	81176	12242	30777
76194	15272	62644	85211	21361	71687
28759	72459	47047	20204	22145	53570
21377	58467	36166	13037	05358	25876
64403	33524	36847	98975	76679	83637
79946	05777	46243	95667	15086	47920
54391	27284	32060	43178	94367	66414
32190	15429	62648	60975	47915	66679
14422	70281	93894	71368	35325	27686
21707	79439	22000			

Message "B"

87560	77444	35211	41109	33772	89084
55415	78586	41056	35506	15844	48995
20110	23777	58199	19437	57052	62714
37174	88756	25154	11724	98779	72367
61813	38507	47890	68719	65521	08875
68548	81270	33609	17554	83811	72477
85433	50805	37598	60718	37306	17704
06159	62714	46551	69370	50945	58696
19561	70681	86600	83474	55377	71502
16576	41295	65052	00751	47289	33956
59497	38764	66574	72261	08560	73763
68350	48516	25000			

~~RESTRICTED~~

9. The following naval messages are suspected to be isologs, containing the probable word "TASK FORCE". Solve them, and recover all keys.

Message "A"

43022 83524 26060 98448 56175 57368
05544 54713 25748 18995 73211 78809
78230 46746 55566 38971 52835 54310
66179 30225 49705 63605 75310 83452
92351 03132 27998 93539 26288 11095
80473 12200 63369 42108 52097 11477
11306 68721 98883 68453 95650 15184
59749 92076 67000

Message "B"

77639 32338 96687 32583 16771 36033
25195 21007 61936 37147 94702 74323
91551 84030 23211 74696 15784 34746
34170 59391 35584 17645 65752 24915
07432 64598 99104 17307 66639 31127
90402 53353 77760 84479 75139 10388
02285 42214 80132 62568 27529 42875
07934 45455 20000

10. The following cryptogram is suspected to begin with the opening stereotype "REFERENCE YOUR MESSAGE....". Solve it, and recover all keys.

40162	42385	52104	83121	44422	37211
99099	42127	37912	77785	80116	44444
13378	77640	12255	50022	48883	78850
22287	84629	99920	06648	91253	20729
01331	81222	90051	99523	19391	41936
61045	48376	88311	15454	00022	05509
60615	57129	18859	20396	66603	14945
35079	88552	82411	08663	05032	28600
07722	55212	00080	00774	72883	40000