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Information and Communications Security
SS 2020
Assignment 2
Cryptography

Please prepare your solutions for the following exercises. We will discuss them on the 26th of May 2020.

Exercise 1 (Caesar Cipher)

A Caesar encryption is given by the following encryption function:

$$e_k: \mathbb{Z}_{26} \rightarrow \mathbb{Z}_{26}, \qquad x \rightarrow (x + k) \mod 26$$

with $k \in \mathbb{Z}_{26}$

a) Encrypt the message "perfect indistinguishability" using e_{10}.

b) What is perfect indistinguishability?

c) Does the condition of perfect indistinguishability hold in general for the Caesar Cipher? Give a two-line explanation.

d) What attacks can be used to break the Caesar Cipher?

Exercise 2 (Stream Ciphers)

a) What is a one-time pad (Vernam-code)?

b) Zoe wants to encrypt the letter Z. The letter is given in ASCII code. The ASCII value for Z is $90_{10} = 1111010_2$. Using Vernam-code, which of the following keys are suitable to encrypt this plaintext?

b1) 11100100
b2) 0011101
b3) 101011

c) Encrypt the message using Vernam-code, XOR as an encryption function and the key in b).

Exercise 3 (Vigenère Cipher)

a) What is the Vigenère Cipher?

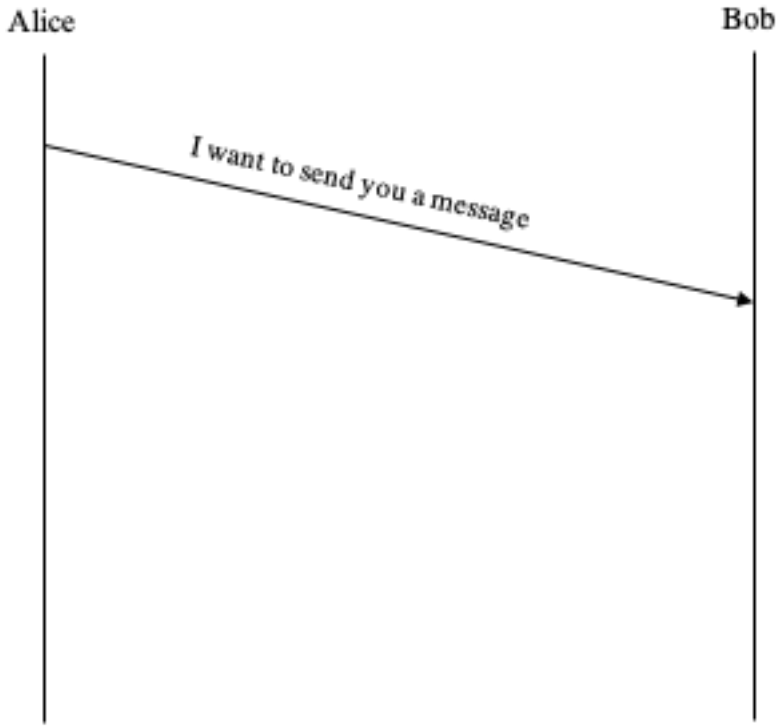
b) In the following you are given the key $k = "GOETHE"$ and the cyphertext $c =$ "CSWMLRJWWMOISCWMIIGIXBMYRQEFWYY". Identify the message m using the running key variant as given in the lecture. Show the necessary steps (use the Vigenére tableau below when necessary).

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

Exercise 4 (Asymmetric Cryptosystems and RSA)

a) Describe differences between symmetric and asymmetric cryptosystems.

b) Alice wants to send a message m to Bob. Because the message is a secret, Alice encrypts the message using RSA. Complete the flow chart below and also show the necessary calculation steps for encryption and decryption. Indicate which information are public or known only by Bob or Alice.



c) Encrypt the message $m = 3$ using RSA. The following keys were made public: $e = 3$, $n = 15$.

d) Decrypt the message c = 2 using RSA. The private key of the receiver is $d = 3$ and $n = 15$.

e) Why is it possible to break RSA with Post-Quantum Cryptography?