COM-501

Advanced cryptography

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Cursus	Sem.	Type
Cyber security minor	E	Opt.
Cybersecurity	MA2, MA4	Opt.
Data Science	MA2, MA4	Opt.
Data science minor	E	Opt.
SC master EPFL	MA2, MA4	Opt.

Language of teaching	English
Credits	4
Session	Summer
Semester	Spring
Exam	Written
Workload	120h
Weeks	14
Hours	**4 weekly**
Courses	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course reviews some failure cases in public-key cryptography. It introduces some cryptanalysis techniques. It also presents fundamentals in cryptography such as interactive proofs. Finally, it presents some techniques to validate the security of cryptographic primitives.

Content

1. **Cryptographic security models:** security notions for encryption and authentication, game reduction techniques
2. **Public-key cryptography:** Factoring, RSA problem, discrete logarithm problem, attacks based on subgroups
3. **Interactive proofs:** NP-completeness, interactive systems, zero-knowledge
4. **Conventional cryptography:** differential and linear cryptanalysis, hypothesis testing, decorrelation
5. **Proof techniques:** random oracles, leftover-hash lemma, Fujisaki-Okamoto transform

Keywords

cryptography, cryptanalysis, interactive proof, security proof

Learning Prerequisites

Required courses

• Cryptography and security (COM-401)

Important concepts to start the course

• Cryptography
• Mathematical reasoning
• Number theory and probability theory
• Algorithmics
• Complexity

Learning Outcomes

By the end of the course, the student must be able to:

• Assess / Evaluate the security deployed by cryptographic schemes

- Prove or disprove security
- Justify the elements of cryptographic schemes
- Analyze cryptographic schemes
- Implement attack methods
- Model security notions

Teaching methods

ex-cathedra

Expected student activities

- active participation during the course
- take notes during the course
- do the exercises during the exercise sessions
- complete the regular tests and homework
- read the material from the course
- self-train using the provided material
- do the midterm exam and final exam

Assessment methods

Mandatory continuous evaluation:

- homework (30%)
- regular graded tests (30%)
- midterm exam (40%)

Final exam averaged (same weight) with the contiuous evaluation, but with final grade between final_exam-1 and final_exam+1.

Supervision

Office hours	No
Assistants	Yes
Forum	No
Others	Lecturers and assistants are available upon appointment.

Resources

Bibliography

- Communication security: an introduction to cryptography. Serge Vaudenay. Springer 2004.
- A computational introduction to number theory and algebra. Victor Shoup. Cambridge University Press 2005.
- Algorithmic cryptanalysis. Antoine Joux. CRC 2009.

Ressources en bibliothèque

- Algorithmic cryptanalysis / Joux
- Communication security / Vaudenay
- A computational introduction to number theory and algebra / Shoup

Websites

- http://lasec.epfl.ch/teaching.shtml