Advanced cryptography

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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. The cryptographic zoo: definitions, cryptographic primitives, math, algorithms, complexity
2. Cryptographic security models: security notions for encryption and authentication, game reduction techniques, RSA and Diffie-Hellman security notions
3. Public-key cryptanalysis: side channels, low RSA exponents, discrete logarithm, ElGamal signature
4. Interactive proofs: NP-completeness, interactive systems, zero-knowledge
5. Symmetric-key cryptanalysis: differential and linear cryptanalysis, hypothesis testing, decorrelation
6. 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 continuous evaluation, but with final grade between final_exam-1 and final_exam+1.

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

Resources
Bibliography

Ressources en bibliothèque
• Algorithmic cryptanalysis / Joux
• A computational introduction to number theory and algebra / Shoup
• Communication security / Vaudenay

Websites
• https://lasec.epfl.ch/teaching.php

Moodle Link
• https://go.epfl.ch/COM-501

Videos
• https://mediaspace.epfl.ch/channel/COM-501+Advanced+Cryptography