COM-440

Introduction to quantum cryptography

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Cursus	Sem.	Type
Computer science	MA1, MA3	Opt.
Cyber security minor	H	Opt.
Cybersecurity	MA1, MA3	Opt.
Data Science	MA1, MA3	Opt.
Quantum Science and Engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	6
Session	Winter
Semester	Fall
Exam	Written
Workload	180h
Weeks	14
Hours	**4 weekly**
Courses	3 weekly
Exercises	1 weekly
Number of positions	

Remark

This course is a « depth » for Cyber Security master program and Cyber Security minor

Summary

This course describes, at a rigorous mathematical level, a range of such tasks, each time identifying the fundamental property of quantum information that makes it possible, its strengths, and its limits.

Content

It has been known since the 1980s that the use of quantum information could enable certain cryptographic tasks, such as quantum money or quantum key distribution, that are impossible classically without making computational assumptions.

- Quantum money: Wiesner's scheme and attacks on it
- The quantum one-time pad
- Entanglement and non-local games
- Quantum key distribution: the BB'84 protocol
- Ekert's protocol and device independence
- Two-party cryptography: bit commitment, oblivious transfer, coin-flipping
- The noisy storage model
- Quantum encryption
- Delegated computation

Learning Prerequisites

Required courses

- An introduction to quantum computation, such as CS-308 Introduction to quantum computation, COM-309 Introduction to quantum information processing or PHYS-541 Quantum computing

Recommended courses

- A course in cryptography such as COM-401 Cryptography and Security can help engage with the material, but is not required

Important concepts to start the course

- Basics of quantum computing, including qubits, density matrices, POVM, quantum gates and circuits
- Discrete mathematics techniques in computer science, such as asymptotic estimates, Chernoff (concentration) bounds
- Algorithmic reasoning

No prior knowledge of cryptography is required, but some familiarity with the principles of quantum information, as well as some background in algorithms or complexity, are highly recommanded.

Learning Outcomes

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

- Design , analyse and show security of cryptographic protocols that make use of quantum information to implement novel tasks with strong security guarantees
- Assess / Evaluate the (theoretical) security of a quantum cryptographic scheme and investigate possible attacks on it
- Learn or solidify your knowledge of quantum computing

Teaching methods

- Ex-cathedra

Expected student activities

- Attend lecture and participate orally
- Perform the required reading and homeworks

Assessment methods

- Homeworks are a combination of small quizzes, problem sets to be solved in small group, and occasional critical reading exercises to be performed alone.
- There will be a midterm and a final exam, which will be similar to problem sets but required to be solved alone.

Supervision

Office hours	Yes
Assistants	Yes

Resources

Bibliography

Vidick and Wehner, Introduction to Quantum Cryptography, Cambridge University Press, 2023.

Ressources en bibliothèque

- Introduction to Quantum Cryptography / Vidick

Moodle Link

- https://go.epfl.ch/COM-440