Principles of computer systems

This advanced graduate course teaches the key design principles underlying successful computer and communication systems, and shows how to solve real problems with ideas, techniques, and algorithms from operating systems, networks, databases, programming languages, and computer architecture.

Content
A modern computer system spans many layers: applications, libraries, operating systems, networks, and hardware devices. Building a good system entails making the right trade-offs (e.g., between performance, durability, and correctness) and understanding emergent behaviors. Great system designers make these trade-offs in a principled fashion, whereas average ones make them by trial-and-error. In this course we develop a principled framework for computer system design, covering the following topics:

• Modules and interfaces
• Names
• Layers
• Indirection and virtualization
• Redundancy and fault tolerance
• Client/server architectures
• Decentralized architectures
• Transactional building blocks

Learning Prerequisites

Required courses
The course is intellectually challenging and fast-paced, and it requires a solid background in operating systems, databases, networking, programming languages, and computer architecture. The basic courses on these topics teach how the elemental parts of modern systems work, and this course picks up where the basic courses leave off. To do well, a student must master the material taught in the following courses:

• COM-208 Computer networks
• CS-208/209 Computer architecture
• CS-210 Functional programming
• CS-305 Software engineering
• CS-322 Introduction to database systems
• CS-323 Introduction to operating systems

Recommended courses
The following EPFL courses cover material that significantly helps students taking this course, however they are not strictly required:

- CS-320: Computer language processing
- CS-470: Advanced computer architecture
- CS-422: Database systems
- COM-407: TCP/IP networking

**Learning Outcomes**

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

- Design computer and communication systems that work well
- Make rational design trade-offs (e.g., performance vs. correctness, latency vs. availability)
- Anticipate emergent system behaviors (e.g., failure cascades, security vulnerabilities)
- Integrate multiple techniques, ideas, and algorithms from different fields of computing/communication into a working system

**Teaching methods**

- A combination of online and in-class lectures
- Interactive design sessions
- Reading assignments
- Homework assignments

**Expected student activities**

- Attend lectures and design sessions
- Complete the reading and writing assignments
- Participate actively in the course (physically and online)

**Assessment methods**

- 30% written assignments (during the semester)
- 10% research presentation (during the semester)
- 10% course participation and discussion (during the semester)
- 50% written final exam (during the exam session)

**Supervision**

- Office hours: Yes
- Assistants: Yes
- Forum: Yes

**Resources**

- Bibliography
  See course website for the latest information and an up-to-date bibliography.
Ressources en bibliothèque

• Principles of computer system design : an introduction / Saltzer

Websites

• https://pocs.epfl.ch