Advanced digital communications

Digital communication systems are basic workhorses behind the information age. Examples include high-speed wired and wireless networks, but also storage technologies such as CDs, hard drives, and flash memory. Yet another example is the Global Positioning System (GPS), which is also based on digital communications. This course is an introduction to the foundational principles underlying the design and analysis of digital communication systems. Principled approaches and mathematical sophistication have had an exceptionally profound impact on the development of these systems. The class will provide the student with a command of the tools and concepts behind present and emerging systems, including OFDM, GSM, 3G, and 4G/LTE.

1. Foundations of Signalling, Detection and Estimation (3 weeks)
2. Wired Communication: OFDM, the foundations behind ADSL and beyond (3 weeks)
3. Wireless Communication: Diversity and the foundations behind LTE/4G Wireless and emerging wireless technologies, including multi-user communication (4 weeks)
4. Coding Techniques (3 weeks)

Keywords
Wireless, OFDM, ADSL, Fading, Diversity, Coding, Modulation, Multi-user communication, GSM, 3G, 4G, LTE

Learning Prerequisites

Required courses
"Principles of Digital Communications"

Recommended courses
"Circuits and Systems" / "Signals and Systems" (in particular, Fourier and Z-transforms).
"Linear Algebra" (concepts of matrices, vectors, eigenvalues)

Important concepts to start the course
Basic familiarity with Fourier transforms, vectors, matrices and eigenvalues, will be an advantage in this class.

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

• Assess / Evaluate an ADC (advanced digital communication) system (data rate, spectral bandwidth, energy requirements, error probability, implementation complexity)
• Design an ADC system (data rate, spectral bandwidth, energy requirements, error probability, implementation complexity)
• Formalize an ADC system (data rate, spectral bandwidth, energy requirements, error probability, implementation complexity)
• Model physical properties of wired and wireless communication channels

Teaching methods
1. Lectures (using blackboard and projector), 4h per week
2. Exercise session, 2h per week

Expected student activities
There will be weekly homework assignments, with the following emphasis:
1. Paper-pencil studies of communication system design (70%)
2. Matlab (or other numerical tools) to evaluate performance (30%)

Assessment methods
1. Homework / Project
2. Midterm Exam
3. Final Exam

Supervision
Office hours: Yes
Assistants: Yes
Forum: Yes

Resources
Bibliography
There is a plethora of books on the topic of Digital Communications. The class will give specific pointers, also via the lecture notes that will be distributed in class.

Ressources en bibliothèque
• Digital Communications / Proakis
• Fundamentals of Digital Communication / Madhow
• Principles of Digital Communication / Gallager
• A Foundation in Digital Communication / Lapidoth

Notes/Handbook
A set of lecture notes will be provided to the students at the beginning of the class.

Websites
• http://ipg.epfl.ch/cms/lang/en/pid/136515

Moodle Link
• http://moodle.epfl.ch