1SC2310 – Principles of wireless telecommunications

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Department: DÉPARTEMENT SIGNAL, INFORMATION, COMMUNICATION
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 22,50

Description

This course is an introduction to wireless communication systems. From Chappe's telegraph (1794) to current cellular systems (2G/3G/4G) and the 5G now being deployed, the problem of exchanging information between a source and a receiver in a reliable and efficient manner is a constant source of innovation. In order to design, test and optimize wireless communication systems it is fundamental to understand the role of all its parts, and to be able to model their individual responses as well as the entire system.

This course deals with wireless communication modeling from different complementary perspectives, taking into account physical phenomena (antennas, wave radiation and propagation, noise, link budgets), information processing (coding, modulation, amplification, diversity, spectral efficiency) and a system-oriented perspective (network architectures, spectrum and power management, data throughput, quality of service).

This course will introduce the main concepts, models and tools required for understanding these topics, used for the analysis and design of real-life wireless communication systems.

Quarter number
ST2

Prerequisites (in terms of CS courses)
None; having taken at least one of the science courses for the "Networks and Security" or "Electromagnetics" engineer in SG1 would be a plus.

Syllabus
Antennas :

- Antenna macromodels from radiation theory
- Main antenna families for communications

- Antenna arrays

Propagation models :

- Wave propagation in free space
- Link budget (Friis equation)
- Deterministic and semi-empirical propagation models
- Propagation models for complex media
- Fading and diversity

Data transmission :

1. Building blocks of a wireless communication link
2. Data coding, modulation, amplification
3. Spectral efficiency and figures of merit (sensitivity threshold, bit rate)
4. Reliability (error rates, availability ratio)

Wireless systems

- Long-distance wireless communications
- Cellular networks
    - Architecture, cell coverage models, spectrum management, interference models
    - Data flow management et traffic models (Erlang laws), quality of service (voice, video, file download)

During tutorial classes students will apply the models introduced during lectures to the analysis and design the main building blocks found in wireless communication systems, in particular for long-distance and cellular communications, highlighting the design criteria applied when choosing among antennas and propagation models, modulations and codes, traffic models and network topologies.

Class components (lecture, labs, etc.)
12 hours of course and 9 heures of Practice Session

Grading
Final exam (80%) : written exam (1h30). Intermediate exam (20%) : one MCQ during one of the tutorial classes.

Course support, bibliography

- Lecture slides
- S. R. Saunder, A. A. Zavala ; Antennas and Propagation for Wireless Communication Systems

- K.L. Du et al., Wireless Communication Systems: From RF Subsystems to 4G Enabling Technologies, Cambridge University Press, 2010
- Réseaux GSM-DCS ; X. Lagrange, P. Godlewski, S. Tabbane ; Hermes

Resources

- Lecturers : Jacques Antoine, Andrea Cozza, Salah-Eddine Elayoubi
- Size of tutorial classes : 25
- Software used : Matlab

Learning outcomes covered on the course

The objective of this course is to provide students with concepts enabling them to choose the most suitable models to solve an engineering problem, namely the design of a communication system subject to multiple constraints, such as regulatory (frequency, power), physical (antennas, propagation), quality of service (error rate, coverage, blocking) and trafic (Erlang distribution).

At the end of this course, students will be able to :

- Model physical phenomena involved in wireless communications
- Choose the most suitable propagation models, depending on the nature and complexity of the environment (free space, urban and indoor, etc.)
- Take into account legal and physical constraints
- Know the main modulations currently used in modern communications
- Compute a link budget and assess its quality of service (bit-error rate, radio coverage)
- Estimate the benefits of using smart antenna solutions in order to counter/take advantage of certain characteristics of complex media
- Understand the phenomena leading to fading and the available solutions at hand to control it
- Understand how trafic affects the design of communication systems
- Choose the most suitable trafic model depending on the type of information to be transmitted (voice, video, data)

Description of the skills acquired at the end of the course

C1.2 : Develop and use appropriate models, choosing the correct modelling scale and simplifying assumptions when addressing a problem

C1.4 : Design, detail and corroborate a whole or part of a complex system.