

Academic Year of Degree: 2025/26

23981 - Mobile Communications

Teaching Guide Information

Academic Course: 2025/26

Academic Center: 337 - Engineering School

Study: 3379 - Bachelor's degree in Telecommunications Network Engineering

Subject: 23981 - Mobile Communications

Credits: 5.0

Course: 4

Teaching languages:

Theory: Group 1: English

Practice: Group 101: English

Seminar: Group 101: English

Group 102: English

Teachers: Angel Lozano Solsona

Teaching Period: First term

Presentation

Wireless Communications is a mandatory course (23981) offered within the degree in Telecommunication Network Engineering at Universitat Pompeu Fabra. It is also an optional course for the degree in Computer Engineering. It is worth 5 ECTS credits and it is offered during the first term of the fourth academic year.

The course has been designed following a methodology adapted to the European Higher Education Area, where the learning revolves around the student. The main objective of this design is to involve the student through sustained practice and individual study as essential complements to the lectures. A high degree of involvement is fundamental to achieve the minimum required knowledge.

All the learning material has been prepared in English, and the lectures are also in English.

The main objective of *Wireless Communications* is the understanding of the basic concepts pertaining to the analysis, design, and operation of wireless communication systems. The course covers these systems broadly, but with a special focus on cellular networks. These systems have achieved, in a handful of years, penetration rates that are unprecedented in the history of technology, and they have become essential tools for citizens and institutions.

Besides the lectures, arranged in a sequence of themes, a relevant component is the resolution of problems, which constitutes an important part of the activity of the student inside and outside the classroom, and which are to be solved collectively during the seminar series. Furthermore, during the practice sessions, groups of students are to work on a project that demands teamwork and the application of the acquired knowledge.

Associated skills | General learning outcomes

Basic

1. That the students can apply their knowledge to their work or vocation of a professional form and possess the competences which are usually proved by means of the elaboration and defense of arguments and solving of problems within their study area.
2. That the students have the ability of collecting and interpreting relevant data (normally within their study area) to issue judgements which include a reflection about relevant topics of social, scientific or ethical nature.
3. That the students can transmit information, ideas, problems and solutions to a public both specialized and non specialized.
4. That the students have developed those learning abilities necessary to undertake later studies with a high degree of autonomy.

Transversal

1. Applying leadership and coordination and proving initiative.
2. Applying with flexibility and creativity the acquired knowledge and adapting it to new contexts and situations.
3. Communicating in academic and professional contexts orally and writing in English.

Specific

1. Solving the mathematical problems which can be set out in the engineering and apply the knowledge on: linear algebra; differential and integral calculus; numerical methods, numerical algorithms, statistics and optimization.
2. Designing, building and assessing electronic systems and circuits.
3. Using the different communication techniques (modulation, codification, synchronization, equalization, etc.) in the design of communication links.
4. Modelling in an abstract way the different elements of a system of telecommunications using concepts and methods of information theory.
5. Developing and using analysis, simulation and experimentation methods in the design, assessment and optimization of telecommunication networks and systems.

Learning outcomes | Specific learning outcomes

The learning objectives are:

- Acquisition of familiarity with the evolution of wireless communications.
- Description of the elements, general operation and purpose of a wireless communications system.
- Knowledge of the current and future applications of wireless communications.
- Discrimination of the various types of wireless communication systems
- Modeling of radio channels.
- Calculation of the theoretical capacity of a radio channel.
- Link adaptation to the channel capacity, as it varies.
- Cell dimensioning and frequency reuse factor in cellular networks.
- Dimensioning of the number of sectors per cell.
- Power control as a function of the user's position within the system.
- Performance improvement with transmit and receive diversity techniques.
- Selection of the best diversity strategy depending on the system.

Contents

- Theme I. Introduction
 - Motivation
 - Fun facts
 - Vision and challenges
- Theme II. Wireless Evolution
- Theme III. Tour of Main Wireless systems
 - Power regulations
 - Spectrum regulation
 - Overview of main systems
 - Comparisons
- Theme IV. Review of Key Topics
 - Log-scale representation of ratios and powers
 - Random variables

- Multiple access techniques
- Passband signals and baseband representation
- Digital data transmission
- OFDM
- Theme V. Wireless Channel Models
 - Electromagnetic waves
 - Antennas
 - The radio channel
 - Pathloss
 - Shadow fading
 - Multipath fading
- Theme VI: Capacity and Link Adaptation
 - A "bit" of information theory
 - Shannon capacity
 - The SNR gap
 - Digital wireless transmission
- Theme VII: Cellular Network Design
 - The cellular concept, revisited
 - Coverage
 - Cellular network geometry
 - Intercell interference
 - Sectorization
 - Cell splitting
 - Power control
- Theme VIII. Fading mitigation
 - The concept of diversity
 - Receiver diversity
 - Selection combining
 - Maximum ratio combining
 - Equal gain combining
 - Transmit diversity
 - With channel knowledge at transmitter
 - Without channel knowledge at transmitter
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Evaluation and grading system

The course grade depends on:

- Final exam (45%). A minimum of 4 points over 10 are required.
- Delivery and presentation of the class project (30%).
- Resolution of problems posed during the seminar sessions (20%). For students missing some seminars, the corresponding fraction of grade will get transferred to the final exam. In the extreme case of a student missing all seminars, this means that 70% of the grade will come from the exam and 30% from the project.
- Score in the quizzes posed through Nearpod (5%).

If the course grade is below 5 (over 10) points, the final exam can be retaken during the month of July. The seminars, the project and the Nearpod quizzes cannot be retaken; their original scores will be preserved as the final grade is recomputed.