VNIVERSITAT DE VALÈNCIA

Course Guide
43854 Advanced Wireless communications and mobility

COURSE DATA

Data Subject	
Code	43854
Name	Advanced Wireless communications and mobility
Cycle	Master's degree
ECTS Credits	5.0
Academic year	2022 - 2023

Study (s)

Degree	Center	Acad. year	Period
2174 - M.U. en Ingeniería de Telecomunicación 13-V.2	School of Engineering	1	First term

Subject-matter

Degree	Subject-matter	Character
2174 - M.U. en Ingeniería de Telecomunicación 13-V.2	8 - Advanced Wireless communications and mobility	Obligatory

Coordination

Name	Department
BOTELLA MASCARELL, CARMEN	240 - Computer Science
SEGURA GARCIA, JAUME	240 - Computer Science

SUMMARY

In Advanced Wireless Communications and Mobility, we study the fundamental principles underlying the design and performance of wireless communication systems. Attention is paid to both theoretical foundations and algorithm design, illustrating the concepts with practical examples drawn from state-of-the-art commercial systems including 5G systems, such as GSM, UMTS, IEEE 802.16 WiMAX, IEEE 802.11 WiFi, and LTE.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

No particular requirements, other than those that grant access to the Master

OUTCOMES

2174 - M.U. en Ingeniería de Telecomunicación 13-V.2

- To have critical thinking capabilities to investigate independently and self-critically, and to search and utilize information for documenting ideas.
- To have the ability of standing up for fair criteria with rigor and arguments, reporting them publicly in a clear way and in a multilingual environment.
- To have the ability to participate in diffusion forums, journals, conferences, etc. and to work cooperatively and effectively in transnational teams.
- To have the capability to identify and solve the critical points to conduct an effective technology transfer, transforming theoretical results into products and services that are useful for the society.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Be able to access to information tools in other areas of knowledge and use them properly.
- To be able to assess the need to complete the scientific, historical, language, informatics, literature, ethics, social and human background in general, attending conferences, courses or doing complementary activities, self-assessing the contribution of these activities towards a comprehensive development.
- Ability to apply information theory methods, adaptive modulation and channel coding techniques, as well as advanced signal processing techniques to audiovisual and communication systems.
- Ability to implement cable, transport and satellite systems in wired and mobile environments.

LEARNING OUTCOMES

By successfully taking this subject, students will learn to:

- Identify the key elements of wireless and mobile digital communication systems and describe their interactions, both in general terms and in practice;
- Model wireless communication channels in a mathematically convenient, yet accurate, form. Relate the model with the fundamental variables that characterize the performance of communication systems: power, bandwidth, and error probability;

- Design of practical algorithms at both transmitter and receiver sides in wireless communication systems, comparing their performance with the fundamental limits derived from information-theoretic tools.
- Identify the advanced techniques that have been adopted in modern wireless commercial communication systems.

Apart from the technical contents, this subject also allows to acquire the following skills and social attitudes:

- Promotion of teamwork: collaboration, leadership, planning, interacting, consensus, negotiation, conflict resolution and respect the views of others.
- Promotion of individual working capabilities, organizing the own work efficiently into tasks and subtasks.

DESCRIPTION OF CONTENTS

1. Introduction to Wireless communication systems

Introduction and historical perspective
Overview of Wireless communication systems
Spectrum considerations: regulatory aspects
Standards for wireless communication systems

2. Review of wireless channel modeling

Channel modeling at large and small scale
Coverage considerations for cell systems
Fading models: slow and fast fading, multi-path fading, time-varying effects, narrow band vs. wide band channels

3. Digital transmission in wireless channels

Digital modulation, coding and detection techniques over fading channels
Channel capacity in fading channels: ergodic capacity, outage capacity
Average error probability
Outage probability
Link adaptation methods(rate and power adaptation)

4. Advanced diversity Techniques

Time diversity, Interleaving, Frequency diversity
Space diversity, Receiver diversity, Selection combining, Maximal-ratio combining,Equal gain combining. Transmitter and receiver multi-antenna diversity, Beamforming,
Multiple-input-Multiple Output (MIMO) communications, MIMO channel modeling, ergodic capacity and outage capacity for wireless MIMO communication systems, Diversity/Multiplexing trade-off, Space-time coding, Mutiplexing architectures, associated standards.

5. Multiple access and Interference management in cellular systems

Cellular concept and architecture, co-channel interference, frequency reuse, sectorization, network dimensioning and cell planning, multiple access and multiplexing techniques, TDMA/FDMA/SDMA/CDMA systems, direct sequence and frequency hopping spread spectrum, random access techniques, CDMA vs. OFDM systems in wideband cellular networks, uplink vs. downlink management, power control, channel assignment, mobility and hands-off, opportunistic multiuser communications, MIMO communications in cellular networks, Device-to-device (D2D) communications, associated standards.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	25,00	100
Tutorials	10,00	100
Laboratory practices	9,00	100
Classroom practices	6,00	100
Development of individual work	20,00	0
Preparation of evaluation activities	15,00	0
Preparing lectures	17,00	0
Preparation of practical classes and problem	19,00	0
Resolution of case studies	4,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

MD 1 - Actividades teóricas. The lectures will develop the subjects in a progressive manner, building on existing knowledge whilst introducing new material in a well-paced manner, emphasizing the most important elements, their relevance for academia and industry. Student participation, being fundamental for the transfer of knowledge during lecture hours, will be actively sought. Individual exams will be taken by the students under the supervision of the professor.

MD 2- Actividades prácticas. These assignments complement the lectures, allowing the students to apply the concepts and tools learnt in the lectures, as well as their own readings. Two activities are scheduled:

- Problems sessions in class
- Lab sessions

Personal work. This autonomous task involves preparation of material before the lectures, for the assignments, as well as for the exam.

Aula Virtual. UV's e-learning platforms (Aula Virtual) will be used to communicate with students. They will also provide access to the material used in the lectures, such as slides, and to the homework assignments.

EVALUATION

The final grade will be computed as a weighted average of the following items:

SE1 – Final exam, consisting of several theoretical-practical questions, as well as problems.

SE2 – Evaluation of the practical activities through the handling of lab reports and homeworks.

SE3 – Evaluation of each student based on in-class participation, taking into account the attendance to the class sessions and scheduled activities during the course.

The final grade, from a maximum of 10, is obtained from the expression:

Grade= 0.60 * SE1 + 0.35 * SE2 + 0.05 * SE3

Criterion SE2 is graded assuming a 55% for the solution of homeworks and a 45% for the handling of the lab sessions' reports.

To evaluate the attendance, the student needs to attend at least 80% of the course lessons. An adequate

document proving the need for the absence is required otherwise.

The lab sessions and homeworks are course activities that are regarded as 'no recuperables', meaning that they should be carried out during the course as part of the continuous evaluation. In the second evaluation of the course, the grades corresponding to the lab sessions and homeworks are kept.

For the students who cannot attend the course lessons, an alternative evaluation is proposed, where the attendance is replaced by solving additional homework. This should be notified to the professor at the beginning of the course.

The minimum mark required to pass the course is 3.5 over 10 in both the final exam and the homework. The remaining items are not subjected to a minimum.

According to the Universitat de València's regulation, copying or performing any fraudulent action during the exams will turn out in a zero qualification and the beginning of the process according to the University regulation.

In any case, the system of evaluation will be ruled by the established in the Regulation of Evaluation and Qualification of the University of Valencia for Degrees and Masters. (http://www.uv.es/graus/normatives/2017_108_Reglament_avaluacio_qualificacio.pdf).

REFERENCES

Basic

- Wireless Communications, Andrea Goldsmith, Cambridge University Press, 2005.
- Fundamentals of Wireless Communications, David Tse, Pramod Viswanath, Cambridge University Press, 2005

Additional

- Principles of Mobile Communications by G. L. Stuber. Third Ed. Kluwer Academic Publishers, 2012
- Wireless Communications, Andreas Molisch, Wiley, 2005