Course guide
300273 - SDR - Software Defined Radio

Last modified: 11/05/2026

Unit in charge: Castelldefels School of Telecommunications and Aerospace Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER IN COMMUNICATIONS ENGINEERING AND DATA SCIENCE (CODAS 1) (Syllabus 2024). (Optional subject).
ERASMUS MUNDUS MASTER IN COMMUNICATIONS ENGINEERING AND DATA SCIENCE (CODAS 2) (Syllabus 2024). (Optional subject).

Academic year: 2026 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Gilabert Pinal, Pere Lluis
Montoro Lopez, Gabriel
Gelonch Bosch, Antonio Jose

Others:

PRIOR SKILLS

The student should have competence in digital processing, radiofrequency, network systems, and good background in mathematics for communications including statistics. Skills in programming, C or C++ for example, and/or simulation tools like Matlab or Octave are desirable.

REQUIREMENTS

Pre: Next Generation Wireless Communications and IoT
Co: None

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
01 MTM. (ENG) Diseñar, implementar y evaluar redes de comunicaciones móviles celulares de última generación, así como de las generaciones previstas para el futuro cercano.
02 MTM. (ENG) Diseñar, implementar y evaluar redes heterogéneas de elevada densidad mediante técnicas de virtualización de la red de acceso.

Generical:
03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.

Transversal:
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.

TEACHING METHODOLOGY

Thanks to the material developed by instructors: slides, class notes, etc. available at the digital campus ATENEA, the student has enough tools to work autonomously, either in groups or individually.
In the theory sessions based on expository classes, the formal explanation of the teacher is combined with informal questions to the students to promote discussion.
In the laboratory sessions, groups will be formed to develop specific mini projects related to the subject areas indicated. Each group will have to write a report indicating the results obtained or show them through a performance demonstration of the implemented system.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student should be able to:
1) Apply proper technologies for designing and managing versatile implementations of powerful, efficient and portable wireless systems.
2) Identify the best solution for each part and component of wireless system attending the flexibility demanded by Cloud RAN approach.
3) Apply optimization methodologies for the complete wireless system, the demanded infrastructure or part of the system.

STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours large group	17,0	22.67
Hours small group	10,0	13.33

Total learning time: 75 h

CONTENTS

Cognitive and Software Defined Radio

Description:
The evolution of wireless systems has followed a long path from the conventional voice-centric cellular systems. The data traffic associated to wireless communications has experienced a high increase thanks to the arrival of multimedia applications. New generation of wireless systems tries to accommodate this increasing demand by means of new transmission technologies and an improved resource management. The improvement in the efficiency of Spectrum use combined with Software Radio and the idea that cognitive learning can be applied to wireless system deployment and management is creating new research and business possibilities. Application of Cognitive Radio and SDR in advanced communications systems constitutes the basis for incorporating learning functions for the management of spectrum and network resources.

Related activities:
1) Lecture.
2) Hands-on wireless project

Full-or-part-time: 3h
Theory classes: 2h
Laboratory classes: 1h

Cloud-RAN

Description:
An emerging term in radio access network (RAN) architecture is defined by "Cloud-RAN" concept. The basic idea behind C-RAN is changing the traditional RAN architecture to take advantage of cloud computing, Software-Defined Radio (SDR), Software-Defined Networks (SDN) and Distributed Antenna Systems (DAS). C-RAN is a RAN architecture that is not bound to a single RAN air interface technology. Essentially, conventional cellular base stations are replaced by small remote radio heads connected by optical fiber to a data center where digital processing of physical layer, and the rest of network layers, is carried out. Current cloud computing management frameworks, like OpenStack, OpenNebula, etc, needs to address the intensive real-time computing requirements of modern and future wireless systems. Incorporation of cloud concepts, like a centralised management that facilitates the extensive use of Coordinated Multi-Point (CoMP) transmission and reception or Inter-cell interference coordination (ICIC) techniques, or the resource virtualization, that promotes the development and evolution of Mobile Virtual Network Operator (MVNO) concepts, promises relevant reduction in CAPEX and OPEX in future wireless networks.

Related activities:
1) Lecture.
2) Hands-on wireless project.

Full-or-part-time: 5h
Theory classes: 3h
Laboratory classes: 2h

Digital signal generation and processing strategies

Description:
Current and future wireless communication standards and its related technologies (LTE, LTE-Advanced, WiMAX, etc) are being defined with enough flexibility to allow the inclusion in the processing chain concepts or subsystems aimed at improving the radio communication capabilities. Among others, we can analyze the impact of including within the transceiver signal processing strategies to improve both signal's integrity and the overall system's efficiency: crest factor reduction techniques to moderate the signal's PAPR, dynamic supply or dynamic load modulation strategies to improve the transceiver efficiency, steerable antennas to perform beamforming, MIMO, or the incorporation of processing components for coordinated transmission (CoMP) or interference mitigation (ICIC), etc.

Related activities:
1) Lecture.
2) Hands-on wireless project.

Full-or-part-time: 6h
Theory classes: 4h
Laboratory classes: 2h

Advanced high-efficient transceiver architectures

Description:
Using the classical Cartesian I-Q transceivers to cope with non-constant envelope modulated signals with high peak-to-average power ratios (LTE, LTE-Advanced, WiMAX) clearly results power inefficient. To overcome this power efficiency limitation, the conventional Cartesian transceiver architectures are being modified or adapted to ensure optimal system-level amplification with highly efficient switching mode RF PAs. System level architectures (some including power supply control) with great potential for high-efficiency operation such as: linear amplification with nonlinear components (LINC), ΔΣ modulator-based or "all-digital" transmitters, envelope tracking (ET) PAs or polar transmitters (PTs), have been revived thanks to current high-speed digital signal processors (DSP) which substitute their analog counterparts, subjected to tolerances and periodic adjustments.

Related activities:
1) Lecture.
2) Hands-on wireless project.

Full-or-part-time: 6h
Theory classes: 4h
Laboratory classes: 2h

Linear and nonlinear characterization and compensation

Description:
In the transmitter, linearity levels specified in the communication standards must be meet at the antenna side. One of the most significant sources of nonlinear distortion within the transmitter is the power amplifier. Linearization techniques are therefore aimed at compensating for any eventual linear or nonlinear distortion threatening the transmitter's linearity specifications. On the other hand, in the receiver side, digital signal processing techniques have to be carried out (e.g. synchronization, channel estimation and equalization) to cope with communication's channel linear distortion and noise and thus guarantee a certain QoS.

Related activities:
1) Lecture.
2) Hands-on wireless project.

Full-or-part-time: 7h
Theory classes: 4h
Laboratory classes: 3h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

The qualification is based on the realization of three mini projects. The qualification of each one of them will be determined by the degree of consecution of the project's specific objectives defined. Each project contributes to the subject's final score with the same percentage.

BIBLIOGRAPHY

Basic:

- Nguyen, Duy H. N; Le-Ngoc, Tho. Wireless coordinated multicell systems : architectures and precoding designs. New York: Springer, [2014]. ISBN 9783319063362.
- Luo, Fa-Long. Digital front-end in wireless communication and broadcasting : circuits and signal processing. Cambridge [etc.]: Cambridge University Press, 2011. ISBN 9781107002135.
- Kenington, Peter B. High-linearity RF amplifier design. Boston [etc.]: Artech House, cop. 2000. ISBN 1580531431.
- China Mobile Research Institute. "C-RAN: The Road Towards Green RAN ". China Mobile Research Institute [on line]. [Consultation: 16/07/2018]. Available on: https://pdfs.semanticscholar.org/eaa3/ca62c9d5653e4f2318aed9ddb8992a505d3c.pdf.- "Network Functions Virtualisation (NFV)". ETSI [on line]. [Consultation: 16/07/2018]. Available on: https://portal.etsi.org/nfv/nfv_white_paper.pdf.

Complementary:

- Wu, Jinsong; Rangan, Sundeep; Zhang, Honggang. Green communications : theoretical fundamentals, algorithms and applications. Boca Raton, FL: CRC Press, cop. 2013. ISBN 9781466501072.
- "Network Functions Virtualisation (use cases)". ETSI [on line]. [Consultation: 16/07/2018]. Available on: https://www.etsi.org/deliver/etsi_gs/NFV/001_099/001/01.01.01_60/gs_NFV001v010101p.pdf.