

## COURSE DESCRIPTION

### Lecturers

Dr. Christian Ibars (CTTC)

Dr. Deniz Gunduz (Imperial College London)

Prof. Erik G. Larsson (Linköping University)

Dr. Xavier Mestre (CTTC)

Dr. Monica Navarro (CTTC)

Prof. Ana I. Pérez-Neira (UPC)

Dr. Stephan Pfletschinger (CTTC)

### Venue

Centre Tecnològic de  
Telecomunicacions de  
Catalunya - CTTC,  
Barcelona

Parc Mediterrani de la  
Tecnologia  
Av. Carl Friedrich  
Gauss, 7 Building B4  
Castelldefels  
(Barcelona), Spain

<http://www.cttc.es/about-cttc/location-and-contact/>

provides details on how to get to CTTC

Cooperative communications systems improve the capacity of wireless communications by allowing cooperation between nodes at the physical layer level. It is possible to use cooperation to implement distributed antenna arrays, which allow the utilization of multiple antenna techniques that can provide the benefits of multiple antennas to single antenna terminals. Recently, multiple antenna processing techniques are being considered in multi-cell scenarios, where by allowing cell coordination and distributed interference and network resource management would lead to a considerable network capacity increased.

The objective of this course is to provide the fundamental tools to understand, analyze, and design cooperative communications systems in general, and distributed array configurations in particular. The lectures will cover the following areas:

1. **Background material:** diversity analysis, performance metrics (bit error rate exponents and channel outage probability), multiple antenna channels, multiuser information theory. Cooperation scenarios, deployment scenarios in cellular networks and other wireless systems.
2. **Cooperation algorithms and analysis:** Cooperative relaying techniques, capacity analysis, diversity gain, diversity-multiplexing gain analysis, resource allocation for cooperation.
3. **Large-scale MIMO:** Basic principles of massive MIMO, aspects of propagation, energy and spectral efficiency, pilot contamination, aspects of precoding, open problems.
4. **Distributed processing:** Coded cooperation and physical layer network coding for multi-hop wireless transmission
5. **Distributed MIMO for cellular networks:** Intercell coordination, Network MIMO, coherence coordination and interference alignment.

The students will understand some of the fundamental tradeoffs involved in wireless communication system design and how collaborative transmission can be used as a tool to improve performance. Students will get insight into basic relaying techniques such as decode-and-forward and amplify-and-forward and also more sophisticated methods. The philosophy of the course is to provide a combination of understanding of fundamental principles and learning of state-of-the-art techniques. Lectures will be given in an interactive style, exploiting the interdisciplinary nature of the topic and a diverse composition of the audience.

<b>Prerequisites</b>	Undergraduate level signal processing for communications (graduate level recommended).
<b>Availability</b>	20 students.
<b>ECTS credits</b>	The ESoA recommends that this course be valued with 3 ECTS credits.
<b>Registration and Fees</b>	Students 440€ Regular 1100€

**Further Information and registration:** for inquires about the course or to register please contact Dr. Monica Navarro ([monica.navarro@cttc.es](mailto:monica.navarro@cttc.es)).