

EEE.8-2.7: Wideband Communications

Wideband Communications is an elective specialization course which aims at introducing students to advanced technologies used in the physical layer of communication systems such as wideband modulation of multiple carriers, spread spectrum systems and multiple antenna systems. The aforementioned technologies are critical to attain wideband transmission in contemporary and future telecommunication systems. In addition, the course covers the basic techniques and algorithms used in the physical layer of contemporary telecommunication systems and networks (wired and wireless) 4G and 5G as well as channel coding, multiplexing, multiple antennas systems, and the capabilities of new generation telecommunication systems and also overviews and justifies the design and implementation choices of various techniques in current standardized technologies and applications, regarding wireless and wired telecommunication networks (such as LTE/LTE-A, IEEE802.11, xDSL), as well as in future systems and next generation networks (5G-NR). It is divided as follows:

Part 1 "Modern Modulation Technologies"

Introduction, block diagram of a telecommunication system, Overview of digital modulations (M-QAM, M-PSK), implementation using digital signal processing principles, Wideband modulation using multiple carriers – OFDM modulation, OFDM receiver, Variations of OFDM (DMT, Windowed OFDM, FBMC, GFDM etc.) SC-FDMA modulation, Applications and implementation features of the physical layer of current technologies and standards for wireless and wired networks (4G LTE/LTE-A, 5G New radio, IEEE802.11 WLAN, xDSL)

Part 2 "Spread Spectrum telecommunication systems"

Spread spectrum system model, Direct Sequence (DS) spread spectrum systems, Applications of DS spread spectrum systems, Generation of Pseudo-noise (PN) sequences, Frequency hopping (FH) systems, Applications of spread spectrum technologies in telecommunication systems (IS-95, 3G-WCDMA, IEEE802.11)

Part 3 "Multiple Antenna Systems"

Channel models for multiple antenna systems, Transmission, Reception and Detection of symbols in slow-fading frequency non selective channels, Capacity of MIMO systems, Channel coding for MIMO systems (Bit interleaving, STBC), Applications of MIMO technologies in standardized wireless networks (4G LTE/LTE-A, 5G, IEEE801.11)

Laboratory Exercises

Laboratory training using the MATLAB/SIMULINK platform. The lab consists of exercises focusing on the main subjects taught in theory. The lab exercises target the following tasks,

- Study of the classical OFDM modulation, Power spectral density of transmitted signals, Probability of error
- Study of the windowed OFDM modulation, Power spectral density of transmitted signals, Probability of error
- Generation of PN sequences and their application in spread spectrum systems
- Multiple access using code division (CDMA)
- Simulation of MIMO systems utilizing Space Time Block Codes (Alamouti coding)
- Simulation of MIMO systems with precoding at the transmitter