FIK3510 Multiple Antenna Communications 9.0 credits

Flerantennkommunikation

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for FIK3510 valid from Spring 2021

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

Enrolled as doctoral student.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After passing the course, the student should

1. be able to describe, apply, and analyze the fundamental limitations when using the wireless medium for communications; in particular, the relations between channel capacity, channel coherence, spatial degrees of freedom, transmission power, pilot contamination, and bandwidth.
2. be able to apply multiple antenna techniques to achieve high capacity in point-to-point as well as multi-user communications, as well as being able to examine and interpret the results.
3. with high precision be able to formulate and solve engineering oriented problems regarding the achievable performance and limits of multiple antenna communications.
4. be able to utilize power control and other resource management parameters to design communication systems that meet given service requirements on spectral efficiency and energy efficiency.
5. be able to implement, validate and compare the main theoretic multiple antenna concepts via computer simulations.

Course contents

Fundamental limits: Capacity behavior as power or bandwidth increases. Examples of practical systems that are power and bandwidth limited. Orthogonal versus non-orthogonal transmission in scenarios with multiple users.

Basic multiple antenna channels: Array gain, capacity of channels with multiple antennas at one side. Modeling of multi-antenna channel responses.

Fading channels: Rayleigh fading channels, outage capacity, diversity, channel coherence, ergodic capacity.

Point-to-point MIMO: Capacity of channels with multiple antennas at both sides, multiplexing gain, spatial degrees of freedom.

Uplink multi-user MIMO: Uplink capacity, non-linear and linear detection, channel estimation, capacity bounds in systems with many antennas.

Downlink multi-user MIMO: Linear precoding, capacity bounds in systems with many antennas, differences and similarities between uplink and downlink.
Power control: Rate region, typical operating points, basic power allocation formulations.

Cellular networks: Engineering aspects of applying multiple antenna techniques in cellular networks, including reuse strategies, pilot contamination, and interference management.

Examination

- EXA1 - Written examination, 9.0 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

The examination consists of three parts: A written exam, laboratory exercises carried out in MATLAB, and a set of homework problems that are solved individually and then actively discussed in joint tutorial sessions.

Other requirements for final grade

The grade on the course is Pass/fail. The requirements for passing the course is at least 2/3 correct answers on the written exam and on the homework problems, correct solutions to the laboratory exercises and a lab report of sufficient quality. Moreover, 90% attendance on the scheduled laboratory exercises and tutorials is required.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.