230647 - ACWS - Advanced Communications for Wireless Systems

Learning objectives of the subject:

The aim of this course is to present advanced concepts on digital communication systems. The course is divided in two main sections, that is, the point-to-point communication theory and the extension to multiuser scenarios. From a definition and a measure of information, the course develops the theory associated to the important concept of channel capacity. Impact of frequency-flat fading channels and frequency selective channels are analyzed. Performance degradations are mitigated through the use of transmission and reception diversity techniques. The extension of all the former concepts to a multiuser framework is done, providing a more rich and interesting context for current and future communication networks.

Learning results of the subject:

- To achieve a solid background on fundamental concepts of digital communications and information theory.
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- Ability to understand the physical layers of modern advanced communication systems in point-to-point and multiuser networks.
- Ability to analyze, characterize and develop the physical layers of modern advanced communication systems in point-to-point and multiuser networks.

**Study load**

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<thead>
<tr>
<th></th>
<th>Hours large group:</th>
<th>Hours medium group:</th>
<th>Hours small group:</th>
<th>Guided activities:</th>
<th>Self study:</th>
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<td><strong>Total learning time:</strong></td>
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## Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Learning time</th>
<th>Description</th>
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| **1. Introduction: A Definition of Information.**                       | 42h           | **Description:**  
  - Discrete memoryless sources and source entropy.  
  - Discrete memoryless channels, mutual Information and channel capacity.  
  - Continuous time-amplitude channels. The Gaussian channel.  
  - Water-pouring and bit-loading approaches. |
| **2. Additive White Gaussian Channel (AWGN).**                           | 7h            | **Description:**  
  - Signalling and optimal detection.  
  - Performance bounds and case studies. |
| **3. Frequency-Flat-Fading Channels: the wireless channel.**            | 16h           | **Description:**  
  - Statistical Models.  
  - Performance degradation and diversity schemes.  
  - Use of the channel-state information.  
  - Slow-fading: outage probability and outage capacity.  
  - Fast-fading: ergodic capacity. |
| **4. Frequency-Selective Channels: the multipath channel.**            | 20h           | **Description:**  
  - Bello’s channel model and channel transfer matrix.  
  - SVD and optimal communication schemes.  
  - OFDMA: Orthogonal Frequency Division Multiple Access.  
  - Hybrid SVD on OFDMA solutions. |
Planning of activities

**EXERCISES**

**EXTENDED ANSWER TEST (MID TERM EXAMINATION)**

**EXTENDED ANSWER TEST (FINAL EXAMINATION)**

Qualification system

Final examination: 60 %
Mid-Term examination: 40 %
Final Grade: The final grade is the maximum between the Final Exam mark and the weighted former mark.

- Ahiswede-Liao multiple-access capacity region.
- Multiple-access schemes and capacity regions: TDMA, FDMA-OFDMA, CDMA.
- Multiuser detection.
- Uplink fading channel.
- Downlink fading channel.
- Multiuser diversity.
Bibliography

Basic:


Complementary:


