CT516: Advanced Digital Communications

Course Description: A graduate level course on the principles of digital communication systems. A digital communication system converts the information to be transmitted into a stream of bits, and then into symbols that can be transmitted over wireline or wireless channels. This concept applies regardless of the type of information generating source (audio, video, image, etc.) and the type of information conveying medium or channel (cable, satellites, microwave and terrestrial links, etc.). The course CT516 will combine elegant mathematics and practical applications. Students will study how the application of mathematics to a branch of engineering has lead to a key enabler of today’s technology - the digital method of communications.

Major topics will include:

- Information Theory and Channel Coding
  - Entropy and Mutual Information, Channel Capacity
  - Quantization, data compression, block and convolutional codes, Turbo and LDPC codes, decoding methods

- Estimation and Detection Theory
  - Maximum A Posteriori Decision Theory, Optimum Receivers, Vector-Space Representation of Signals, Probability of Error Analysis, Energy and Spectral Efficiency

- Transceiver Signal Processing
  - Modulation Theory and Transmitter Design (PSK and QAM modulation formats, pulse shaping, Direct Digital Synthesis), Demodulation Theory and Receiver Design (symbol timing, carrier frequency and phase offset estimation), Intersymbol Interference and Channel Equalization, Flat and Frequency Selective Channel Fading, SIMO Diversity for Fade Mitigation, MIMO Architectures

- Multiple Access Schemes
  - Spread Spectrum Communications and CDMA
  - OFDM and SC-FDMA
Textbooks:  
• Main:  
• Supplementary:  
  → Additional supplementary material will be made available throughout the semester.

Homework and Projects: There will be several (five to seven) homework assignments, more frequent at the start of the semester, and becoming less frequent as the semester progresses.  
There will be two project assignments. These will start later in the semester. One of these two will be a research project and will require the student to undertake a detailed study of research paper/research topic. The second project will require a software implementation (e.g., in Matlab, Python or C++) of a communications algorithm. An oral presentation and a written project report will be required.  
The course will have a two-hour lab session per week.

Exams: There will be two mid-semester and one end-of-the-semester examination.

Honor Policy: You may confer with your classmates on interpretation and approach to solving homework and/or project problems, however, the submitted solution should entirely be your own. All outside sources of information should be clearly referenced.

Grading:  
• Homework: 15%  
  • Two mid-term exams: 15% each  
  • Final Exam: 25%  
  • Project: 30%

Credit Breakdown: L-T-P-Cr: 3-0-2-4