ECE 515  
Modern Digital Communications – Course Syllabus  
Spring 2010  
Instructor: Guillermo Atkin

Office: SH – 141, 312-567-6810  
Office Hours: TBA  
e-mail: atkin@iit.edu  
Class Hours: M and W: 13:50 to 15:05 PM, E1 - 242

Description: Review of modulation and coding. Trellis coded modulation. Digital signaling over fading multipath channels. Spread spectrum signals for digital communications. Multiple access systems, time-division multiple access, code-division multiple access, frequency-division multiple access. OFDM communications systems.

Prerequisites:
- ECE 513 and ECE 511 (or instructor consent)
- Understanding of continuous and discrete linear systems.
- Knowledge of probabilities and random variables.
- Understanding of digital modulation methods and optimum receiver.
- Knowledge of block and convolutional codes. Encoding and decoding.
- Knowledge of evaluation of probabilities of error in and AWGN channel.

Textbook: Digital Communications, by John G. Proakis and Salehi, McGraw-Hill Book Company, 4th edition (There is a 5th edition with some updates, but unfortunately it uses a different approach that the one used in the textbook for ECE 513, so it makes it very difficult to follow. You can get it at your own risk, but will require significant work in matching equations, some of them missing).

References:
Course Outline:

Review of Modulation and Coding Theory
i. Review of the main components of a Digital Communication System
ii. Review of Block Codes - Convolutional codes
iii. Lattices

Trellis Coded Modulation (TCM)
i. Introduction and Fundamentals
ii. Trellis Representation
iii. Set Partitioning
iv. Examples of TCM schemes
v. Decoding TCM
vi. Performance Evaluation in AWGN channel
vii. Upper Bound to Error Probability
viii. Lower Bound to Error Probability
ix. Examples
x. Computation of dfree

Digital Signaling over Fading Multipath Channels
i. Characterization of Fading Multipath Channels
ii. The Effect of Signal Characteristics on the Choice of a Channel Model
iii. Diversity Techniques for Fading Multipath Channels
iv. Digital Signaling over a Frequency-Selective, Slowly Fading Channel
v. Binary and M-ary Signaling over a Frequency-Nonselective, Slowly Fading Channel
vi. Coded Waveforms for Fading Channel
vii. Probability of Error. Hard and Soft Decision
viii. Performance of Convolutional Codes
ix. Constant Weight and Concatenated Codes
x. Analysis and Performance of TCM for Fading Channels

Spread Spectrum Signals for Digital Communications
i. Model of a Spread Spectrum Communications System
ii. Direct Sequence Spread spectrum Signals
iii. Rake Receivers
iv. Multi-user Detection
v. Frequency Hopped Spread Spectrum Signals
vi. Other types of Spread Spectrum Signals
vii. Spread Spectrum in multipath channels

Multiuser Communications
i. Multiple Access Techniques (CDMA, TDMA, FDMA, SDMA, PDMA)
ii. Capacity of Multiple Access Systems.

Multichannel and Multicarrier System
i. Multichannel Digital Communications in AWGN
ii. Multicarrier Communications

OFDM
i. Introduction
ii. Transmitter and Receiver Structure
iii. Performance Analysis

Grading.

Coursework will be graded as follows:

<table>
<thead>
<tr>
<th>Coursework</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Homework</td>
<td>10% (every week, due Mondays)</td>
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<tr>
<td>Projects</td>
<td>15%</td>
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<tr>
<td>Exams 1</td>
<td>25% (TBA)</td>
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<tr>
<td>Exams 2</td>
<td>25% (TBA)</td>
</tr>
<tr>
<td>Final exam</td>
<td>25% (TBA)</td>
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Homework solutions will be posted in the Blackboard on Wednesdays. HW should be submitted (hard copies) at the beginning of the class on Mondays (MC section) or using the Digital Dropbox (Blackboard) for other sections. No late HW will be accepted without previous instructor consent.

Grade scale:

- A: 86 – 100
- B: 71 – 85
- C: 60 – 70

Reasonable accommodations will be made for students with documented disabilities. In order to receive accommodations, students must obtain a letter of accommodation from the Center for Disability Resources and make an appointment to speak with me as soon as possible. The Center for Disability Resources is located in the Life Sciences Building, room 218, 312-567-5744 or disabilities@iit.edu.