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**ECE 515**  
**Modern Digital Communications – Course Syllabus**  
Spring 2014  
Instructor: Guillermo Atkin

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**Office:** SH – 141, 312-567-6810  
**Office Hours:** T and R: TBA  
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**Class Hours:** TBA

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**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.
- Understanding 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** (4<sup>th</sup> is preferred).

**References:**

- Introduction to Trellis-Coded Modulation with Applications, by Ezio Biglieri, Dariush Divsalar, Peter J. McLane and Marvin K. Simon. Macmillan Publishing Company, 1991.
- Communication System Engineering by John Proakis and M. Salehi, Prentice Hall, Second Edition.
- Principles of Communication Engineering by J. M. Wozencraft and I. M. Jacobs. Wiley, 1967.
- Error-Correction Coding for Digital Communications by G. C. Clark, Jr. and J. B. Cain. Plenum Press, 1981.
- Error Control Coding: Fundamentals and Applications by S. Lin and D. J. Costello. Prentice-Hall, 1983.
- Information Theory and Reliable Communication by R. G. Gallager. Wiley, 1968.
- Digital Communications. B. Sklar, Prentice-Hall, 2001.

## **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  $d_{free}$

### **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:

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|---------------|-----|----------------------------|
| 1. Homework   | 10% | (every week, due Tuesdays) |
| 2. Projects   | 20% | (TBA)                      |
| 3. Exams 1    | 20% | (02/16/2012)               |
| 4. Exams 2    | 25% | (03/29/2012)               |
| 5. Final exam | 25% | (TBA)                      |

HW should be submitted before the beginning of the class on Tuesdays (MC section) using the Digital Dropbox (Blackboard) for other sections the due date is Thursday before the class. Homework solutions will be posted in the Blackboard on Friday. No late HW will be accepted without previous instructor consent.

**Grade Policy:** A ( $\geq 90\%$ ); B(80 - 89%); C(66 - 79%); D(50 - 65%)

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](mailto:disabilities@iit.edu).