Digital Communications

Course Outline

Po-Ning Chen, Professor

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National Chiao-Tung University, Taiwan

Syllabus

- Instructor: Po-Ning Chen 陳伯寧
  - Office: ED831
  - Email: poning@faculty.nctu.edu.tw
  - Course website: http://shannon.cm.nctu.edu.tw
- Teaching Assistants:
  - Chia-Hong Lin 林家鴻 ED823 bh.chlin@gmail.com
  - Yi-Ann Wu 吳益安 ED823 jesse0282@gmail.com
- Prerequisites:
  - Probability, Random Process, and Introduction to Communication Systems (preferred)

Syllabus

- Textbook:
  - John G. Proakis and Masoud Salehi, *Digital Communications*, 5th edition, McGraw-Hill International Editions, 2008.
- References:
  - Andrew J. Viterbi, CDMA Principles of Spread Spectrum Communication, Addison-Wesley Wireless Communications Series, 1995.
  - R. G. Gallager, Principles of Digital Communication, Cambridge University Press, 2008.
  - A. Lapidoth, A Foundation in Digital Communication, Cambridge, 2009.

- Schedule:
  - Thursday BCD
- Classroom:
  - ED B01
- Office Hours: To Be Determined...

Course Content

- Chapter 1: Introduction
  1. 1.1: Elements of a Digital Communication System
  2. 1.2: Communication Channels and Their Characteristics
  3. 1.3: Mathematical Models for Communications
  4. 1.4: A Historical Perspective in the Development of Digital Communications

- Chapter 2: Deterministic and Random Signal Analysis
  1. 2.1: Bandpass and Lowpass Signal Representations
  2. 2.2: Signal Space Representations of Waveforms
  3. 2.7: Random Processes
     (2.7.2 *Cyclostationary Process* will be incorporated into Chapter 3.)
  4. 2.8: Series Expansion of Random Processes
  5. 2.9: Bandpass and Lowpass Random Processes

Course content

- Chapter 3: Digital Modulation Schemes
  1. 3.1: Representation of Digitally Modulated Signals
  2. 3.2: Memoryless Modulation Methods
  3. 3.3: Signaling Schemes with Memory
  4. 3.4: Power Spectrum of Digitally Modulated Signals
- Chapter 4: Optimum Receivers for AWGN Channels
  1. 4.1: Waveform and Vector Channel Models
  2. 4.2: Waveform and Vector AWGN Channels
  3. 4.3: Optimal Detection and Error Probability for Band-Limited Signaling
  4. 4.4: Optimal Detection and Error Probability for Power-Limited Signaling
  5. 4.5: Optimal Detection in Presence of Uncertainty
  6. 4.6: A Comparison of Digital Signaling Methods
  7. 4.8: Detection of Signaling Schemes with Memory: Maximum Likelihood Sequence Detector (Viterbi Detector)

Course content

- Chapter 5: Carrier and Symbol Synchronization
  1. 5.1: Signal Parameter Estimation
  2. 5.2: Carrier Phase Estimation
  3. 5.3: Symbol Timing Estimation
  4. 5.4: Joint Estimation of Carrier Phase and Symbol Timing
  5. 5.5: Performance Characteristics of ML Estimators
- Chapter 6: An Introduction to Information Theory
  1. 6.5: Channel Models and Channel Capacity
  2. 6.6: Achieving Channel Capacity with Orthogonal Signals

  (These two sections will be incorporated into Chapter 4.)

Course content

- Chapter 9: Digital Communication Through Band-Limited Channels
  1. 9.1: Characterization of Band-Limited Channels
  2. 9.2: Signal Design for Band-Limited Channels
  3. 9.3*: Optimum Receiver for Channels with ISI and AWGN
  4. 9.4*: Linear Equalization

  (The last two sections will be partially covered!)

- Chapter 11: Multichannel and Multicarrier Systems
  1. 11.1: Multichannel Digital Communications in AWGN Channels
  2. 11.2: Multicarrier Communications

Course content

- Chapter 13: Fading Channels I: Characterization and Signaling
  1. 13.1: Characterization of Fading Multipath Channels
  2. 13.2: The Effect of Signal Characteristics on the Choice of a Channel Model
  3. 13.3: Frequency-Nonselective, Slowly Fading Channel
  4. 13.4: Diversity Techniques for Fading Multipath Channels
  5. 13.5: The RAKE Demodulator

We will **not** cover ...

- Chapter 6: An Introduction to Information Theory

  Will be covered by Information Theory (消息理論)

- Chapter 7: Linear Block Codes

  Will be covered by Error Correcting Codes (編碼理論)

- Chapter 8: Trellis and Graph Based Codes

  Will be covered by Error Correcting Codes (編碼理論)

- Chapter 10: Adaptive Equalization

  Special topic in Digital Communications

We will **not** cover ...

- Chapter 12: Spread Spectrum Signals for Digital Communications

  Will be covered when our course schedule allows

- Chapter 14: Fading Channels II: Capacity and Coding

  Advanced topics in Information Theory and Error Correcting Codes

- Chapter 15: Multiple Antenna Systems

  Advanced topics in Digital Communications

- Chapter 16: Multiuser Communications

  Advanced topics in Digital Communications

Evalutation policy

- Homework: None
- Quizzes: None
- Two Midterms (each 30%) and Final 40%
  - Closed Books: Most of the problems will be from the slides.
- First Midterm: Chapters 2, 3 and 4
- Second Midterm: Chapters 12 and 13
- Final: Chapters 9 and 11 (possible Chapter 5)