Digital Communications Course Outline

Po-Ning Chen, Professor

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# 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
  - Shou-Jung Lu 呂邵蓉 ED823 shana375@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:
  - Wednesday BCD
- Classroom:
  - SC204

# Course Content

#### • Chapter 1: Introduction (Self-Study)

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

#### • Chapter 2: Deterministic and Random Signal Analysis

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

## Course content

### • Chapter 3: Digital Modulation Schemes

- 3.1: Representation of Digitally Modulated Signals
- 3.2: Memoryless Modulation Methods
- 3.3: Signaling Schemes with Memory
- 3.4: Power Spectrum of Digitally Modulated Signals

### • Chapter 4: Optimum Receivers for AWGN Channels

- 4.1: Waveform and Vector Channel Models
- **2** 4.2: Waveform and Vector AWGN Channels
- 4.3: Optimal Detection and Error Probability for Band-Limited Signaling
- 4.4: Optimal Detection and Error Probability for Power-Limited Signaling
- 4.5: Optimal Detection in Presence of Uncertainty
- 4.6: A Comparison of Digital Signaling Methods
- 4.8: Detection of Signaling Schemes with Memory: Maximum Likelihood Sequence Detector

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• Chapter 6: An Introduction to Information Theory

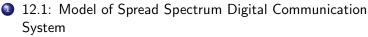
- 6.5: Channel Models and Channel Capacity
- 6.6: Achieving Channel Capacity with Orthogonal Signals

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

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

## Course content

• Chapter 12: Spread Spectrum Signals for Digital Communications



- 2 12.2: Direct Sequence Spread Spectrum Signals
- Chapter 9: Digital Communication Through Band-Limited Channels
  - 9.1: Characterization of Band-Limited Channels
  - 9.2: Signal Design for Band-Limited Channels
  - 9.3\*: Optimum Receiver for Channels with ISI and AWGN (partially covered)
  - 9.4\*: Linear Equalization (partially covered)

## Course content

• Chapter 11: Multichannel and Multicarrier Systems

- 11.1: Multichannel Digital Communications in AWGN Channels
- 2 11.2: Multicarrier Communications
- Chapter 5: Carrier and Symbol Synchronization
  - 5.1: Signal Parameter Estimation
  - 5.2: Carrier Phase Estimation
  - 5.3: Symbol Timing Estimation
  - 5.4: Joint Estimation of Carrier Phase and Symbol Timing
  - 5.5: Performance Characteristics of ML Estimators

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 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

- No Homework and Quiz. Sample Problems will be given weekly.
- Midterm 50% and Final 50%
  - Closed Books: Most of the problems will be from the slides.
- Midterm (November 21): Chapters 2, 3, 4 and 6
- Final (January 9): Chapters 13, 12, 9, 11 and 5