EITG05 – Digital Communications

Preliminary Course Outline
(check regularly, some details may change)

Lectures:
Michael Lentmaier

Exercises:
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August 20, 2017

Week 1, Lecture 1

Chapter 1: Introduction

Chapter 2: Model of a digital communication system

- 2.1 Introduction
- 2.2 An overview
- 2.3 The transmitter: basic concepts
- 2.4 Signal constellations

  2.4.1 Pulse amplitude modulation (PAM)

Pages 1 – 32

Exercises: Problems 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8

Week 1, Lecture 2

Chapter 2: Model of a Digital Communication System

- 2.4 Signal constellations

  2.4.1 Pulse amplitude modulation (PAM)

  2.4.2 Phase shift keying (PSK)

  2.4.3.1 Frequency shift keying (FSK)

  2.4.4 Pulse position modulation (PPM)

  2.4.5 Quadrature amplitude modulation (QAM)

  2.4.6 Pulse width modulation (PWM)

  2.4.7.1 Multitone signaling: OFDM

Pages 31 – 55 (excluding 2.4.3.2)

Exercises: Problems 2.11, 2.12, 2.13, 2.14a, 2.28, 2.15

Week 2, Lecture 1

Chapter 2: Model of a Digital Communication System

- 2.5 The bandwidth of the transmitted signal

  2.5.1 Basic Fourier transform concepts

  2.5.2 $R(f)$: M-ary transmission

  2.5.3 $R(f)$: binary signaling

  2.5.4 Some definitions of bandwidth

Pages 61 – 72 (excluding 2.5.1.2) and 77 – 88

Exercises: 2.18, 2.16, 2.17a, 2.19a, Example 2.17 on page 64

Week 2, Lecture 2

Chapter 2: Model of a Digital Communication System

- 2.5 The bandwidth of the transmitted signal
  - 2.5.5 $R(f)$: M-ary PAM signals
  - 2.5.6 $R(f)$: M-ary QAM signals
  - 2.5.7 $R(f)$: OFDM-type of signals
  - 2.5.8 $R(f)$: M-ary FSK signals

Pages 88 – 102

Exercises: 2.21a,b, 2.22, 2.23, 2.25, 2.29

Week 3, Lecture 1

Chapter 3: Information Transmission with Carrier Modulation Techniques

- 3.1 Bandpass signals: basic concepts
- 3.2 Digital information transmission
- 3.3 Analog information transmission
  - 3.3.1 Amplitude modulation
  - 3.3.2 Frequency modulation

Pages 117 – 136 and 139 – 152

Exercises: 2.26, 2.27 (only 2,3,4,7), 2.30, Example 3.1 on page 121, 3.1, 3.2, 3.3

Week 3, Lecture 2

Chapter 3: Information Transmission with Carrier Modulation Techniques

- 3.4 Bandpass filtering
  - 3.4.3 N-ray channel model
- 3.5 Interference and noise
  - 3.5.3 Noise

Chapter 4: Receivers in Digital Communication Systems – Part I

- 4.1 Introduction
- 4.2 Basic concepts and principles
- 4.3 The minimum Euclidean distance receiver

Pages 167 – 184 (excluding 3.5.1 - 3.5.2) and 227 – 244

Exercises: 3.5, 3.6, Example 3.7 on page 135, 3.9, 3.10b, 3.19, 3.7, 3.22

Week 4, Lecture 1

Chapter 4: Receivers in Digital Communication Systems – Part I

- 4.3 The minimum Euclidean distance receiver
  - 4.3.1 Matched filter implementation
- 4.4 Binary signaling
  - 4.4.1 P_b for minimum Euclidean distance receiver
    - 4.4.1.1 Equally likely signal alternatives
    - 4.4.1.2 Binary signaling over N channels
    - 4.4.1.3 Non-ideal receiver filter $v(t)$ and threshold B

Pages 244 – 272

Exercises: 3.11c, Example 3.19 on page 168, 3.23, 4.1, 4.2, 4.6

Week 4, Lecture 2

Chapter 4: Receivers in Digital Communication Systems – Part I

- 4.5 M-ary signaling
- 4.6 Receiver structure for the linear filter channel model

Chapter 5: Receivers in Digital Communication Systems – Part II

- 5.1 The MAP receiver for the AWGN channel
  - 5.1.1 A geometric description
- 5.2 Comparisons
  - 5.2.1 Energy efficiency

Pages 272 – 293, 329 – 331 and 360 – 366

Exercises: 4.7, 4.8, 4.27, 4.10, 4.17c, 4.20, 4.29, Example 4.12 on page 260, 4.32

Week 5, Lecture 1

Chapter 5: Receivers in Digital Communication Systems – Part II

- Fig. 5.17: gap to capacity
- 5.4.3 A simplified model of multiuser communication
- 5.4.5 Differential phase-shift-keying

Chapter 6: Intersymbol Interference

- 6.1 Increasing the signaling rate – ISI

Pages 369, 395 – 396, 400 – 403, and 435 – 446

Exercises: 4.19, 4.21, Example 4.19 on page 279, 4.13, 4.12, Example 4.4 on page 242, 4.18

Week 5, Lecture 2

Chapter 6: Intersymbol Interference

- 6.2 Nyquist condition for ISI-free reception
  - 6.2.1 Equivalent condition in frequency domain
  - 6.2.2 Spectral raised cosine spectrum
  - 6.2.4 An introduction to equalizers

Pages 446 – 459 (excluding 6.2.3)

Exercises: 4.22, 4.28, 4.30b, Example 4.22 on page 285, 4.35, 4.36

Week 6, Lecture 1

Equivalent baseband model of a communication system

Chapter 3.6: Receivers for Bandpass Signals

- 6.6.1 Homodyne reception

Chapter 3.7: A Compact Description

Pages 184 – 189 and 201 – 205

Exercises: 6.1a, 6.1c, 6.2, 6.3a, 6.4, 6.7a, 6.9a, 6.8

Laboratory takes place during weeks 6 and 7
each of you has to attend one lab session (4 hours)

Week 6, Lecture 2

Last lecture

- Summary of the course
- Outlook

Exercises: 6.10, 6.5, 6.6, 6.11b

Laboratory takes place during weeks 6 and 7
each of you has to attend one lab session (4 hours)

Week 7

No lectures in this week

Exercise 1: problems about equivalent baseband model
(available on course webpage)

Exercise 2: time for questions

Laboratory takes place during weeks 6 and 7
each of you has to attend one lab session (4 hours)

Week 9

Examination

Written exam on Thursday, October 26, 14.00 – 19.00, MA 10A–E

You are allowed to use the compendium during the written exam