Topics in Signals and Codec course - part 1

This document describes the structure and the content of the first (signals) part of the signals and codes course. The topics below do not necessarily have to be contained in one lecture.

Contents

1 Relevant resources

1.1 Fundamental resources

Only specific parts from the books, presentations stated below are covered in this course.

1. Introduction to Signals and Systems
2. Signals and codes - Path and modulation (presentation)
3. **McClellan, Schafer and Yoder, Signal Processing First, ISBN 0-13-065562-7., Prentice Hall, Upper Saddle River, NJ 07458. 2003 Pearson Education, Inc.**
4. **Hrdina, Z., Vejražka, F.: Signály a soustavy. [skriptum] Praha, ČVUT, 1998**
5. Signal Fundamentals - presentation

1.2 Additional resources

- Wickert, M.: Course materials for ECE 2610 Introduction to Signals and Systems, Spring 2011. OpenCourseWare (http://www.eas.uccs.edu/wickert/ece2610/), University of Colorado
- Oppenheim, A.: Course materials for 6.007 Signals and Systems, Spring 2011. MIT OpenCourseWare (http://ocw.mit.edu/), Massachusetts Institute of Technology
- Gallager, R.: Course materials for 6.450 Principles of Digital Communications I, Fall 2006. MIT OpenCourseWare (http://ocw.mit.edu/), Massachusetts Institute of Technology
- Modulace signálu a jejich vliv na spektrum signálu, bakalářská práce, VŠB 2009

2   Bonus points conditions

- Computing of exercises in other than proprietary SW (i.e. Scilab or Python with libraries NumPy, SciPy).
- Commissioning of Matlab demos in resources extra\CD_SK.ZIP.
  con2dis is working properly, what about the others?

3   Signals topics in the course

3.1 Signal types and properties

Topics:

- categorization of a signal (by continuity ...)
- causal and finite signal, odd and even signal
- signal transformations (in time, scale and value)
- special signals: unit step, unit impulse, dirac impulse, sinusoids, exponentials
- instantaneous value, power, average power, energy of a signal
- energy and power signals
- mutual power, mutual energy of a signal
- correlation and convolution

Relevant literature:

[1, chapter 1.1] + [5, p1-56] + CZ [4, chapter 1.1-1.6]

3.2 Sinusoids

Topics:

- basic characteristics of sinusoids (period, amplitude, phase shift, cyclic frequency, radian frequency)
- trigonometric properties, summation of sinusoids

Relevant literature:

[1, chapter 1.1] + [3, chapter 2] + CZ [4, chapter 2]

3.3 Complex exponentials

Topics:

- analytical description of complex exponential
- review of complex numbers
- Euler´s formula in complex exponentials … relation to sinusoids
- inverse Euler formulas
- phasor, phasor addition, rotating phasor, complex amplitude
- negative and positive frequency concept
- sinusoid (Phasor) addition rule

Relevant literature:

[3, chapter 3] + CZ [4, chapter 2]

3.4 Spectrum analysis - Euler's formula

Topics:

- phasor addition, sum of complex exponentials
- amplitude and phase two sided spectrum of a signal
- spectrum representation of analytically defined signal composed of sinusoidal signal
- representation of a signal as a sum of sinusoids

Relevant literature:

[3, chapter 3] + CZ [4, chapter 2]

3.5 Spectrum analysis - Fourier series

Topics:
- Fourier analysis of a signal.
- representation of any periodic signal as summation of harmonically related sinusoids
- signal decomposition and synthesis
- complex amplitude computation inference
- Fourier series of square signal
- meaning of harmonics and fundamental period / frequency
- from Fourier series to Fourier transformation.

Relevant literature:
[3, chapter 3] + CZ [4, chapter 2]

3.6 Sampling and Aliasing

Topics:
- continuous vs discrete signal, sampling period
- sampling theorem
- normalized radian frequency
- signal reconstruction
- aliasing and folding
- sampled signal and its further use.

Relevant literature:
[3, chapter 4] + partially CZ [4, chapter 2]

3.7 Communication system (overview)

Topics:
- structure of a communication system,
- communication system block description
- signal representation and basic notation
- noise and attenuation in channel
- reasons for modulation

Relevant literature:
[1, chapter 1.1] + [2, p1-22] + CZ [4, chapter 1.1-1.2, 8 (p179)]

3.8 Modulations (overview)

Topics:
- focus on the channel adaptation block = modulations
- modulation terminology (broadband / baseband)
- modulations categorisation by carrier wave type and information signal type
- brief description of modulations
    - C-C: AM (DSB, SSB, DSB-RC, DSB-SC, VSB, ISB), FM, PM
    - C-D: ASK, FSK, PSK (BPSK, QPSK, 16PSK), QAM (4,16,64)
    - D-C: PAM, PPM, PWM
    - D-D: DM, PCM
- "broadband" modulations, adaptation, types: NRZ, Manchester

Relevant literature:
[1, chapter 1.1] + [2, p23-118] + CZ [4, chapter 8]