Signal Processing in Acoustics (5p)

Preliminary course description

Course administration: Patrik Andersson / Torbjörn Johansson

The course consists of lectures and Matlab implementations with follow-up discussions. For lectures and discussions blocks of 4h in the afternoon will be scheduled. Implementations are made at your own (1-2 persons together) and should be finished before next lecture, where the outcome will be discussed. Lectures will generally be given by Torbjörn and some by Patrik. In addition we will ask some of the participants to give a review of their experience with some of the methods. Examination is by hand-in of short reports explaining your implementation and results, and by active participation in lectures and discussions.

Contents:

1. Introduction and Systems (Linearity, Causality, Time invariance, Impulse response, Frequency response function, Correlation) (3h)

    Lecture: Torbjörn

2. Sampling (sampling frequency, aliasing, sample and hold, quantisation noise, dithering) (2h)

    Lecture: Torbjörn

    Implementation: Dithering (1 day)

3. Discrete Fourier Transform (Fast Fourier Transform Algorithm, Windowing and leakage, Zero-padding, Create an impulse response from a transfer function, Cepstrum and quefrency) (3h)

    Lecture: Torbjörn/Patrik/Astrid/Patrick

    Implementation: Create an impulse response from a transfer function using different methods (2 days)

4. System analysis using stochastic signals (Auto- and cross-spectra, Double sided and single sided spectra, Transfer functions estimators, Coherence functions, Signal-to-noise ratio) (2h)

Lecture: Patrik

Implementation: Script for system analysis using stochastic signals (1 day)

5. Filters (Z-transform, FIR, IIR, Prototypes, Filter difference equations, Design criteria, Filter banks, Minimum phase, Group delay) (4h)

Lecture: Torbjörn/Patrik/Jonas/Eskil

Implementation: Octave / 1/3-octave band filter banks. (2 days)

6. Signal conditioning (Up- and down sampling, Smoothing in time and freq. domain (Hilbert transform)) (2h)

Lecture: Torbjörn

Implementation: Improved octave / 1/3-octave band filter banks. (1 day)

7. Model-based signal processing (AR, MA, ARMA signal models, Model (system) identification - least squares methods, Adaptive filtering: LMS, RLS, RPE, Optimal (Wiener) filtering) (4h)

Lecture: Torbjörn/Eskil/Jonas

Implementation: Adaptive filter. (2 days)

8. Non-stationary signals (Spectrogram, Wavelets) (3h)

Lecture: Torbjörn/Patrik/Peter/Maarten

Implementation: Spectrogram analysis, Discrete cosine “wavelet” (2 dagar)

Administrative summary:

Lectures: 23h + 7 h discussions = 30 h

Implementation: 11 days

All together: about 15 days + some days for reading => 5 points

Preliminary scheduel

	Date	**Topic**
1	Mars 20, 13-17	Introduction and Systems
2	Mars 22, 13-17	Sampling
3	Mars 27, 13-17	Discrete Fourier Transform
4	April 17, 13-17	System analysis using stochastic signals
5a	April 24, 13-17	Filters Part 1
5b	April 26, 13-15	Filters Part 2
6	May 3, 13-17	Signal conditioning
7	May 10, 13-17	Model-based signal processing
8	May 22, 13-17	Non-stationary signals
9	May 29, 13-15	Final discussion