



LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Optimal och adaptiv signalbehandling Optimum and Adaptive Signal Processing

EITN60, 7,5 credits, A (Second Cycle)

Valid for: 2023/24

Faculty: Faculty of Engineering, LTH

Decided by: PLED BME

Date of Decision: 2023-04-13

General Information

Elective for: BME4-sbh, C4, D4-ssr, E4-ss, E4-bg, F5, F5-ss, MSOC2, MWIR2, Pi4-ssr

Language of instruction: The course will be given in English

Aim

The course provides basic knowledge in statistical signal processing and the theory of optimal methods and how they can be applied. The course presents signal processing methodology and solutions to problems where digital systems tune in automatically and adapt to the environment. The student is given enough theoretical and practical knowledge to independently be able to formulate the mathematical problem, solve it and implement the solution for use with real-life signals.

Learning outcomes

Knowledge and understanding

For a passing grade the student must

- have knowledge about and understand the main concepts in optimum and adaptive filter theory
- be able to apply the most commonly used methods to real problems and real-life signals (Matlab-level)
- be able to formulate mathematical problems based on described situations

Competences and skills

For a passing grade the student must

- be able to explain the main principles behind the most common adaptive methods (LMS and RLS)

- be able to explain/calculate the convergence and stability properties for these methods
- be able to sketch the most common block diagrams/structures used for adaptive filters and their properties
- be able to set parameters needed to make the algorithms work
- be able to foresee the consequences for the algorithms when implemented in fixed-point arithmetic
- be able to implement adaptive filters

Judgement and approach

For a passing grade the student must

- have the ability to analyze, evaluate and implement adaptive algorithms, and be able to interpret and describe the principles which they are based on.
- have the insight that many different technical problems can be solved using the same methods.

Contents

Optimum filtering

- Wiener filters
- Linear prediction
- The Levinson-Durbin algorithm

Basics about adaptive filters

- From optimal to adaptive filters
- Cost functions, minimization problems and iterative procedures
- Convergence and tracking capability, implementation aspects
- Strategies for how to connect adaptive filters

The LMS family

- Principle and derivation
- Convergence analysis and parameter settings
- Variants including Normalized LMS, Leaky LMS, Fast LMS and Sign LMS
- Matlab implementation
- LMS in fixed-point arithmetic
- Principle and derivation
- Parameter settings

The RLS family

- Aspects when used
- Matlab implementation
- Numerical properties

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)

Assessment: The grade is based on the exam in the end of the course.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts

Code: 0119. **Name:** Written Exam.

Credits: 6. **Grading scale:** TH. **Assessment:** Written Examination.

Code: 0219. **Name:** Project.

Credits: 1,5. **Grading scale:** UG. **Assessment:** Project Report.

Admission

Assumed prior knowledge: EITF75 Digital signal processing OR EITA50 Signal processing in multimedia OR EITF15, BMEF25 Digital signal processing - theory and applications OR BMEA05 Signals and systems OR EITG10 Systems, Signals and Discrete Transforms

The number of participants is limited to: No

The course overlaps following course/s: ETTN05, ETT042

Reading list

- Haykin S: Adaptive Filter Theory, Fifth Edition. Pearson, 2014, ISBN: 0-273-76408-X.

Contact and other information

Course coordinator: Frida Sandberg, frida.sandberg@bme.lth.se

Course coordinator: Martin Stridh, martin.stridh@bme.lth.se

Course homepage:

<http://www.bme.lth.se/course-pages/optimal-och-adaptiv-signalbehandling/optimum-and-adaptive-signal-processing/>

Further information: Exercises 14 h, computer exercises 14 h and laboratory work 2 x 4 h. The course might be given in English. With less than 16 participants, the course may be given with reduced teaching and more self studies.