Blekinge Institute of Technology
Department of Applied Signal Processing

COURSE SYLLABUS

Flerdimensionell signalbehandling

Multidimensional Signal Processing

7,5 ECTS credit points (7,5 högskolepoäng)

Course code: ET2403
Educational level: Advanced level
Course level: A1N
Field of education: Technology
Subject group: Electrical Engineering

Subject area: Electrical Engineering
Version: 10
Applies from: 2011-06-17
Approved: 2011-06-17
Replaces course syllabus approved: 2009-11-01

1 Course title and credit points
The course is titled Multidimensional Signal Processing/Flerdimensionell signalbehandling and awards 7,5 ECTS credits. One credit point (högskolepoäng) corresponds to one credit point in the European Credit Transfer System (ECTS).

2 Decision and approval
This course is established by The Board of the Department of Electrical Engineering 2007-03-07. The course syllabus was revised by School of Engineering and applies from 2011-06-17.

3 Objectives
The course aims at making the student expand her/his knowledge within digital signal processing to multidimensional signals and systems, e.g. analysis and construction of multidimensional filters and spectral analysis of multidimensional signals. The applications in the course mainly deal with two-dimensional signal processing, i.e. image processing.

4 Content
Central items of the course are:
Signals, systems, Fourier- and Z-transform
• Two-dimensional signals and linear time-invariant systems
• The Fourier transform and the frequency concept for two-dimensional signals, e.g. images
• The sampling theorem for two dimensions
• Two-dimensional Z-transform, convergence, pole surfaces and stability
• Two-dimensional difference equations, recursive countability and masks
• Two-dimensional DFT and FFT
• The discrete cosinus transform
Multidimensional digital filters
• FIR filters: zero-phase filter, the window method, the frequency sampling method, the frequency transformation method
• Optimal filter design
• IIR-filter: Design in spatial domain
• Design in frequency domain
• Implementation
• Stabilization
Spectral estimation
• Two-dimensional stochastic processes
• Correlation and spectral density
• The Wiener filter
• Methods for spectral estimation based on the Fourier transform
• High-definition methods, the Maximum Likelihood Method, the Maximum Entropy Method
• Autoregressive signal modeling
Image processing
• Bases for image processing
• Representation of color images
• Image enhancement: contrast amplification, histogrammodification, spatial noise reduction, high-pass filtration
• Homomorphic image processing
• Low-pass filtration
• Median filtration
• Edge detection
• Motion estimation
• Image reconstruction: Wiener filtration
• Spectral subtraction

5 Aims and learning outcomes
After completion of the course the student will:
•be able to understand and apply the concept multidimensional signal processing.
•be able to understand and use relevant frequency transformations in various dimensions, e.g. the Z-transform, the Fourier transform.
•be able to design and use filters according to given specifications in various dimensions.
•be able to estimate effect spectra according to classical methods.
•have a basic understanding of digital processing of

images, and be able to make use of ordinary linear and non-linear filter structures.

6 Generic skills

7 Learning and teaching
The teaching comprises lectures, laboratory work, project work and exercises. During the arithmetical exercises the theory is applied to signal processing problems.
In order to further explain the theory and its applications compulsory laboratory work assignments form part of the course. The laboratory work assignments are based on programming assignments where program packages for signal and image processing are used. The laboratory work assignments can be done individually or in a group.
The project assignment consists of the student making an in-depth study of one of the image processing methods that are brought up in the course. The laboratory work assignments and the project assignment are compulsory and will be solved individually or in a group.
The teaching language is partly, or fully, English

8 Assessment and grading
Examination of the course

Code	Module	Credit	Grade
	Exam[1]	6 ECTS	F/P/3/4/5
	Laboration	1.5 ECTS	U/G

[1] Determines the final grade for the course, which will only be issued when all components have been approved.
The course will be graded Fail, Pass, 3, 4 or 5 .The examination will take place through a written examination and also through presentation of the compulsory laboratory work assignments and the project assignment. The project assignment is presented through an oral presentation. The final grade for the course requires a Pass in all components and final grade for the course is given by the score on the exam.
On request grades according to ECTS will be given.

9 Course evaluation
The course coordinator is responsible for systematically gathering feedback from the students in course evaluations and making sure that the results of these feed back into the development of the course.

10 Prerequisites
For admission to the course the following course is required: Signal Processing II, ET1303 7,5 credit points

11 Field of education and subject area
The course is part of the field of education and is included in the subject area Electrical Engineering.

12 Restrictions regarding degree
The course cannot form part of a degree with another course, the content of which completely or partly corresponds with the contents of this course.

13 Course literature and other teaching material
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