Universitat de les Illes Balears

Teaching guide

Academic year	2016-17
Subject	11573 - Advanced Techniques in Digital Signal Processing
Group	Group 1, 1S
Teaching guide	A
Language	English

Subject identification

Subject	11573 - Advanced Techniques in Digital Signal Processing
Credits	1.2 de presencials (30 hours) 3.8 de no presencials (95 hours) 5 de totals (125 hours).
Group	Group 1, 1S (Campus Extens)
Teaching period	First semester
Teaching language	English

Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Felipe Riera Palou felip.riera@uib.es	15:30	17:30	Monday	12/09/2016	31/07/2017	Despatx 109

Contextualisation

Digital signal processing (DSP) is clearly one of the key enablers of the digital revolution. Advances in processing power and ADC/DAC capabilities (coupled with their dramatic prize fall), have caused many analog devices to be replaced by their digital counterpart. In particular, DSP is the driving force underpinning mobile and fixed communications, medical imaging devices, digital broadcasting, sensor networks, navigation systems, radar and sonar equipments and a plethora of other technologies. Students of the Degree (Grau) in Telecommunications, in any of its branches, usually take one or more introductory courses in digital signal processing during their undergraduate studies. Time limitations cause such introduction to mainly focus on the mathematical tools (e.g., DFT and Z-transforms, discrete linear system theory) leaving little or no time at all to cover the more applied side of the subject.
The aim of this course, after a concise review of background material, is to fill in this gap by exploring two of the most generic group of techniques that have ample ground for application, namely, filter design and adaptive/optimal signal processing. Presentation of the material will consist of theory and problem sessions alongside lab projects that are set to emphasize the applications of these techniques to practical signal processing problems.

Requirements

Students are required to have had previous exposure to signal processing-related modules such as Fonaments de Processat Digital de Senyal or Senyals i Sistemes.

Recommendable

Knowledge of the material introduced in Processat digital de senyal (PDS), Senyals i sistemes (SiS) and probabilitat i processos aleatoris (PIPA) from Grau en Enginyeria Telemàtica.

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Basic knowledge of Matlab.

Skills

Specific

* CETT1: Capacidad para aplicar métodos de la teoría de la información, la modulación adaptativa y codificación de canal, así como técnicas avanzadas de procesado digital de señal a los sistemas de comunicaciones y audiovisuales..
* CETT2: Capacidad para desarrollar sistemas de radiocomunicaciones: diseño de antenas, equipos y subsistemas, modelado de canales, cálculo de enlaces y planificación.
* CETT3: Capacidad para implementar sistemas por cable, línea, satélite en entornos de comunicaciones fijas y móviles..
* CETT4: Capacidad para diseñar y dimensionar redes de transporte, difusión y distribución de señales multimedia..
* CETT5: Capacidad para diseñar sistemas de radionavegación y de posicionamiento, así como los sistemas radar..

Generic

* CG4: Capacidad para el modelado matemático, cálculo y simulación en centros tecnológicos y de ingeniería de empresa, particularmente en tareas de investigación, desarrollo e innovación en todos los ámbitos relacionados con la Ingeniería de Telecomunicación y campos multidisciplinares afines..

Transversal

* CB4: Que los estudiantes sepan comunicar sus conclusiones y los conocimientos y razones últimas que las sustentan a públicos especializados y no especializados de un modo claro y sin ambigüedades..

Basic

* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: http://estudis.uib.cat/master/comp_basiques/

Content

The material in this module can generally be seen as an overview of filtering methods, both deterministic and stochastic.

Theme content

Unit 0. Review

-Presentation, organization and rational of the module's material
-Time representation of signals
-Sampling
-Definition and properties of discrete-time LTI signals and systems
-The discrete Fourier transforfm (DFT) and its properties
-The Z transform and its properties

Unit 1. Filter design

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-Practicalities of filter design

* -Practical filter characteristics
* -Transient vs steady-state behaviour
* -Causality
* -Linear-phase
* -Common filters: resonator, notch, comb, all-pass
* -FIR vs IIR

-FIR filter design

* -Windowing-based designs
* -Frequency-sampling method
* -Optimum method

-IIR filter design

* -Analog filters approximations: Chebyshev and Butterworth
* -Bilinear transformation design

Unit 2. Optimal and adaptive signal processing

-Stochastic filters

* -Statistical metrics in discrete signals
* -Optimal linear filters: properties and computation
* -Maximum SNR filters (matched filter)
* -Minimum MSE filters (Wiener)
* -Linear prediction
* -Power spectrum estimation: the periodogram

-Adaptive filters

* -Applications of adaptive filters
* -Least mean squares (LMS) algorithm, its variants and properties

Unit 3. Real-time signal processing

-Introduction to hardware for real-time signal processing

-Introduction to the TI OMAP L-138 DSP development kit

Teaching methodology

Presentation of the material will consist of theory and problem sessions alongside lab projects that are set to emphasize the applications of these techniques to practical signal processing problems.

In-class work activities

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theory sessions	Large group (G)	To introduce the theoretical contents of the module.	16
Seminars and workshops	Problem sessions	Medium group (M)	To reinforce the theory content through problems	6
Laboratory classes	Lab sessions	Medium group (M)	To gain hands-on experience by mean of Matlab and/or dedicated hardware of the main concepts worked out in the theory/problem classes	8

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At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Distance education work activities

Modality	Name	Description	Hours
Individual self-study	Study	To consolidate the concepts covered in class.	95

Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

Student learning assessment

A minimum mark of 5 must be attained in all projects and the final exam. Module's mark will be defined by (Mark Project 1+Mark Project 2) x 0.3 + Final Exam x 0.7.

The skills defined by CETT1, CETT2, CETT3 and CETT4 will be assessed by means of the final exam and to, a lesser extent, by the project reports. Given that projects will focus more on practical problems, these will serve to evaluate the skills defined in CG4. The reports of the projects will evaluate the skill defined as CB4.

Theory sessions

Modality	Theory classes
Technique	Objective tests **(retrievable)**
Description	To introduce the theoretical contents of the module.
Assessment criteria	The final exam amounts to 70% of the overall course mark. A minumum mark of 5 should be attained in the exam.

Final grade percentage: 70% with minimum grade 5

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Lab sessions

Modality	Laboratory classes
Technique	Student internship dissertation **(retrievable)**
Description	To gain hands-on experience by mean of Matlab and/or dedicated hardware of the main concepts worked out in the theory/problem classes
Assessment criteria	There will be two matlab-based projects each carrying equal marks and amounting to 30% of the overall course mark. Each project must attain a minimum mark of 5 (in scale 0-10)

Final grade percentage: 30% with minimum grade 5

Resources, bibliography and additional documentation

Course notes will be posted in the corresponding module's area of UIBdigital.

Basic bibliography

Main reference:
Applied Digital Signal Processing
Dimitris G. Manolakis, Vinay K. Ingle
Cambridge University Press 2011

Complementary bibliography

Complementary references
Understanding Digital Signal Processing, 3rd Ed.
Richard G. Lyons
Prentice Hall 2010
Digital Signal Processing: principles, algorithms and applications, 4th Ed.
John G. Proakis and Dimitris G. Manolakis
Prentice Hall 2006
Schaums Outline of Digital Signal Processing, 2nd Ed.
M. Hayes
McGraw-Hill 2011
Digital Signal Processing and Applications with the OMAP-L138 eXperimenter
Donald Reay
Wiley 2012

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