ANX-PR/CL/001-01

LEARNING GUIDE

SUBJECT

593000423 - Audio and video signal processing

DEGREE PROGRAMME

59AG - Eit Digital Track On Internet Technology And Architecture

ACADEMIC YEAR & SEMESTER

2018/19 - Semester 1

Index

Learning guide

1. Description

1.1. Subject details

Name of the subject	593000423 - Audio and video signal processing
No of credits	5 ECTS
Type	Optional
Academic year ot the programme	First year
Semester of tuition	Semester 1
Tuition period	September-January
Tuition languages	English
Degree programme	59AG - Eit digital track on internet technology and architecture
Centre	59 - Escuela Tecnica Superior de Ingenieria y Sistemas de Telecomunicacion
Academic year	2018-19

2. Faculty

2.1. Faculty members with subject teaching role

Name and surname	Office/Room	Email	Tutoring hours *
Jose Manuel Pardo Martin	D8414	josemanuel.pardo@upm.es	Sin horario. Please, contact by e-mail
Cesar Benavente Peces	A7007	cesar.benavente@upm.es	Sin horario. Please, contact by e-mail

Ruben Fraile Muñoz (Subject coordinator)	A7009	r.fraile@upm.es	Sin horario. Please, contact by e-mail

* The tutoring schedule is indicative and subject to possible changes. Please check tutoring times with the faculty member in charge.

3. Prior knowledge recommended to take the subject

3.1. Recommended (passed) subjects

El plan de estudios Eit Digital Track On Internet Technology And Architecture no tiene definidas asignaturas previas recomendadas para esta asignatura.

3.2. Other recommended learning outcomes

- MATLAB

- Digital Signal Processing (BSc level)

- Signals and Systems (BSc level)

4. Skills and learning outcomes *

4.1. Skills to be learned

CB.06 - To have knowledge that provides the basis or the opportunity of being original to develop and/or to apply ideas, usually in a research context.

CB.07 - To apply the acquired knowledge, as well as problem solving abilities, to new or not well-known environments in broader (or multidisciplinary) contexts that are in the framework of their expertise area.

CB.10 - To have the learning abilities to continue studying in a mostly self-guided or autonomous manner.

CE.07 - To propose, organize and execute research works in the framework of the Information Society engineering.

CESE.01 - To analyze and develop processing techniques to enhance audio and video signals.

CESE.02 - To analyze and design audio and image signal recognition algorithms.

4.2. Learning outcomes

RA27 - Analyze and apply common transforms to audio and video signals.

RA28 - Choose the right spectral estimation technique for the application.

RA30 - Design filter banks for audio and video signals and apply them to transforming, coding and recognition.

RA2 - RA10 - Improvement of the skills for autonomous learning

RA29 - Select and apply enhancement methods for images.

RA26 - Ability to analyze and design systems and services for the Information Society.

* The Learning Guides should reflect the Skills and Learning Outcomes in the same way as indicated in the Degree Verification Memory. For this reason, they have not been translated into English and appear in Spanish.

5. Brief description of the subject and syllabus

5.1. Brief description of the subject

This course presents a variety of digital signal processing techniques applied to audio and video signals. These techniques underlie enhancement, coding and recognition algorithms that are implemented in many systems. Part of such enhancement algorithms are also reviewed in this course, while coding and recogniton schemes are the core contents of the courses on "Advanced Audiovisual Coding" and "Signal Recognition Techniques" taught during the second semester.

5.2. Syllabus

1. Adaptive filtering
    1.1. Wiener filter
    1.2. Least Mean Squares (LMS)
    1.3. Recursive Least Squares (RLS)
    1.4. Kalman filtering
2. Spectral estimation
    2.1. Estimation of signal power or energy
    2.2. Estimation of spectral power density
    2.3. Discrete Fourier transform (DFT) and fast Fourier transform (FFT)
    2.4. Goertzel algorithm
    2.5. Short-time Fourier transform
    2.6. Pamateric methods: autoregressive (AR) and autoregressive moving average (ARMA)
3. Filterbanks for audio signals
    3.1. Oversampling, subsampling, downsampling, and upsampling
    3.2. Polyphase representation of FIR filters
    3.3. Perfect reconstruction filterbanks - Quadrature mirror filter (QMF) and the MPEG specification
    3.4. Fiterbanks by windowing and transform - Overlap-Add (OLA) techniques
    3.5. Spectral subtraction techniques in frequency domain
4. Audio and video enhancement
    4.1. Noise and degradation models
    4.2. Image enhancement in spatial domain
    4.3. Image enhancement in frequency domain
    4.4. Audio enhancement
5. Signal transforms
    5.1. Hough transform
    5.2. Karhunen-Loewe transform
    5.3. Walsh-Hadamard transform

5.4. Time-frequency analysis - Wavelet and Haar transforms

5.5. Multiresolution analysis - 2D Wavelet transforms

6. Schedule

6.1. Subject schedule*

Week	Face-to-face classroom activities	Face-to-face laboratory activities	Other face-to-face activities	Assessment activities
1	**Unit 1: Adaptive filtering** Duration: 02:00	**Adaptive filtering** Duration: 01:00		
2	**Unit 1: Adaptive filtering** Duration: 02:00	**Adaptive filtering** Duration: 01:00		**Assignment on adaptive filtering** Continuous assessment Duration: 05:00
3	**Unit 2: Spectral estimation** Duration: 01:00	**Spectral estimation** Duration: 02:00		
4	**Unit 2: Spectral estimation** Duration: 01:00	**Spectral estimation** Duration: 02:00		
5	**Unit 2: Spectral estimation** Duration: 01:00	**Spectral estimation** Duration: 02:00		**Assignment on Spectral Estimation** Continuous assessment Duration: 05:00
6	**Unit 3: Filterbanks for audio signals** Duration: 01:00	**Filterbanks for audio signals** Duration: 02:00		
7	**Unit 3: Filterbanks for audio signals** Duration: 01:00	**Filterbanks for audio signals** Duration: 02:00		
8	**Unit 3: Filterbanks for audio signals** Duration: 01:00	**Filterbanks for audio signals** Duration: 02:00		**Assignment on Filterbanks** Continuous assessment Duration: 05:00
9	**Unit 4: Audio and video enhancement** Duration: 01:30	**Audio and video enhancement** Duration: 01:30		
10	**Unit 4: Audio and video enhancement** Duration: 01:30	**Audio and video enhancement** Duration: 01:30		
11	**Unit 4: Audio and video enhancement** Duration: 01:30	**Audio and video enhancement** Duration: 01:30		**Assignment on Audio and Video Enhancement** Continuous assessment Duration: 05:00
12	**Unit 5: Signal transforms** Duration: 01:30	**Signal transforms** Duration: 01:30		

13	**Unit 5: Signal transforms** Duration: 01:30	**Signal transforms** Duration: 01:30		
14	**Unit 5: Signal transforms** Duration: 01:30	**Signal transforms** Duration: 01:30		**Assignment on Signal Transforms** Continuous assessment Duration: 05:00
15				
16				
17				**Written Exam** Continuous assessment Duration: 02:00 **Final Exam** Final examination Duration: 03:00 **Lab Exam** Final examination Duration: 03:00

The independent study hours are training activities during which students should spend time on individual study or individual assignments.

Depending on the programme study plan, total values will be calculated according to the ECTS credit unit as 26/27 hours of student face-to-face contact and independent study time.

* The subject schedule is based on a previous theorical planning of the subject plan and might go to through experience some unexpected changes along throughout the academic year.

7. Activities and assessment criteria

7.1. Assessment activities

7.1.1. Continuous assessment

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
2	Assignment on adaptive filtering		No Presential	05:00	13%	/ 10	CESE.01 CESE.02
5	Assignment on Spectral Estimation		No Presential	05:00	13%	/ 10	CB.06 CESE.01 CESE.02
8	Assignment on Filterbanks		No Presential	05:00	13%	/ 10	CB.06 CB.10 CESE.02
11	Assignment on Audio and Video Enhancement		No Presential	05:00	13%	/ 10	CB.07 CB.10 CE.07 CESE.01
14	Assignment on Signal Transforms		No Presential	05:00	13%	/ 10	CB.06 CB.07 CE.07 CESE.02
17	Written Exam		Face-to-face	02:00	35%	4 / 10	CB.06 CB.07 CESE.01 CESE.02

7.1.2. Final examination

Week	Description	Modality	Type	Duration	Weight	Minimum grade	Evaluated skills
17	Final Exam		Face-to-face	03:00	60%	4 / 10	CB.06 CB.07 CESE.01 CESE.02
17	Lab Exam		Face-to-face	03:00	40%	/ 10	CB.07 CB.10 CE.07 CESE.01 CESE.02

7.1.3. Referred (re-sit) examination

No se ha definido la evaluación extraordinaria.

7.2. Assessment criteria

To pass the course by the continuous evaluation process, each student must submit all five assignments and to obtain at least 4 points out of 10 in the written exam. If these conditions are fulfilled, the final mark will be obtained by weighting each partial mark as indicated in the table above. The final mark should be equal or greater than 5 points out of 10 in order to pass de course.

In case a student opts for the single final exam, this will consist of a 6 hour test (3 hours corresponding to a written exercise and 3 hours corresponding to a computer exercise). A minimum of 4 points is required in the written exam, and a minimum of 5 points in the overall mark, considering the weights indicated in the table.

8. Teaching resources

8.1. Teaching resources for the subject

Name	Type	Notes
Kahrs, M. (Editor) and Brandenburg, K., Applications of digital signal processing to audio and acoustics, Kluwer Academic Publishers, Boston, 1998.	Bibliography	
Gay, S.L. and Benesty, J. (ed.), Acoustic signal processing for telecommunication, pp.181-282, Kluwer Academic Publishers, Massachusetts, 2000.	Bibliography	
Mitra, S.K., Digital signal processing, McGraw-Hill, New York, 2006 (existe una versión reciente en español).	Bibliography	

Quatieri, T.F., Discrete-time speech signal processing: principles and practice, Prentice Hall, 2002.	Bibliography	
Adaptive Signal Processing, B. Widrow & P. Stearns, New Jersey, Prentice-Hall, Inc., 1985	Bibliography	
Tratamiento digital de señales. Principios, algoritmos y aplicaciones. John G. Proakis y Dimitris G. Manolakis. Ed. Prentice Hall, 1997.	Bibliography	
Discrete-Time Signal Processing, Alan V. Oppenheim y Ronald W. Schafer, Ed. Prentice-Hall, 1989.	Bibliography	
Stork, David G. Computer manual in MATLAB to accompany pattern classification, John Wiley & Sons, 2004	Bibliography	
C.L. Phillips & J.M. Parr, Sygnals Systems and Transforms. Prentice Hall 2007.	Bibliography	
R.J. Clarke. In: Transform Coding of Images, Academic Press, London (1985)	Bibliography	