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270211 - SIS - Signals and Systems

Coordinating unit: 270 - FIB - Barcelona School of Informatics

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Teaching unit Compulsory)

ECTS credits: 6 Teaching languages: Spanish

Prior skills

The knowledge acquired in the subjects of the Degree in the previous semester.

Degree competences to which the subject contributes

Basic:

CB5. That the students have developed those learning skills necessary to undertake later studies with a high degree of autonomy

Specific:

CE5. Design and apply techniques of signal processing, choosing between different technological tools, including those of Artificial vision, speech recognition and multimedia data processing.

Generical:

CG1. To design computer systems that integrate data of provenances and very diverse forms, create with them mathematical models, reason on these models and act accordingly, learning from experience.

CG2. Choose and apply the most appropriate methods and techniques to a problem defined by data that represents a challenge for its volume, speed, variety or heterogeneity, including computer, mathematical, statistical and signal processing methods.

CG5. To be able to draw on fundamental knowledge and sound work methodologies acquired during the studies to adapt to the new technological scenarios of the future.

Transversal:

CT5. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically evaluate the results of such management.

Teaching methodology

The course is based on face-to-face theory and laboratory classes. The theory classes follow the program defined in this teaching guide.

Within the theory classes, the dialogue between the teacher and the students is promoted, providing problems and joint activities based on particular aspects of the topic being discussed.

The laboratory classes focus on the topics of Fourier Transform, filtering and processing of 2D signals. They are based on computer programs and are guided by a text.

Learning objectives of the subject

1.1. The student must be able to understand and be proficient on the basic concepts of signals, linear systems and related functions and transformations.
2.2. The student must know how to do the mathematical analysis of signals and systems in the time and frequency,domains both in analogue and digital environments.
3.3. The student must know how to interpret and use discrete signals and systems in 1D and 2D in the temporal / spatial and frequency domains.

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4.4. The student must be able to apply the frequency representation of signals and systems to solve various applications.
5.5. The student must be able to evaluate discrete filters and apply them to real systems
6.6. The student must know how to correctly formulate a problem from the proposed statement and identify the options for its resolution, apply the appropriate resolution method, and validate the solution.
7.7. The student must know how to identify, model and solve problems from open situations. Also to explore and apply the alternatives for resolution. He will work with approximations.
8.8. The student must know how to use autonomously the tools, instruments and software applications available in the laboratories of the basic and advanced subjects. He should know their performances and limitations.
9.9. The student should know additional tools useful for processing discrete generic signals in 1D and 2D in the time and transformed domains.
10.10. The student must be able to evaluate advantages and disadvantages of different technological alternatives to implement analysis systems for analog and discrete signal in 1D and 2D.

Study load

Total learning time: 150h	Hours large group:	30h	20.00%
	Hours small group:	30h	20.00%
	Guided activities:	0h	0.00%
	Self study:	90h	60.00%

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Content

Signals and Systems

Degree competences to which the content contributes:

Description:
Signals and systems.
Characterization of signals and sequences, energy and power.
Analog and discrete systems, properties.
Impulse response and convolution equation.
Discrete systems represented by equations in differences.
Impulse response (FIR and IIR systems)

Fourier transform of analog signals.

Degree competences to which the content contributes:

Description:
Definition and properties.
Frequency response.
Examples: Filtering, packaging, modulation.

Sampling.

Degree competences to which the content contributes:

Description:
Sampling Theorem.
Interpolation formula.
Conversion A/D, D/A.

Fourier transform of discrete signals.

Degree competences to which the content contributes:

Description:
Definition and Properties
Discrete Fourier Transform. DFT-1D.

Filtering.

Degree competences to which the content contributes:

Description:
Z transform.
Design of filters. Specifications template. Design tools.
Linear phase filters, filters runs all over.

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Interpolation and decimation.

Degree competences to which the content contributes:

Description:
Interpolation and decimation.
Changing the sampling frequency.

2D Signal Processing

Degree competences to which the content contributes:

Description:
Linear & Invariant Systems, Convolution and Filtering, Fourier Transform, 2D sampling, DFT-2D, Interpolation and Decimation.

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Planning of activities

Topic 1	Hours: 22h 06m Theory classes: 8h Practical classes: 3h Laboratory classes: 0h Guided activities: 1h 06m Self study: 10h
Description: Theory classes and problems corresponding to topic 1 Specific objectives: 1, 2, 6	

Topic 2	Hours: 15h 06m Theory classes: 3h Practical classes: 1h Laboratory classes: 0h Guided activities: 1h 06m Self study: 10h
Description: Theory classes and problems corresponding to topic 2 Specific objectives: 1, 2, 4, 6, 7	

Topic 3	Hours: 15h 06m Theory classes: 3h Practical classes: 1h Laboratory classes: 0h Guided activities: 1h 06m Self study: 10h
Description: Theory classes and problems corresponding to topic 3 Specific objectives: 1, 2, 3, 4, 6, 7	

Topic 4	Hours: 29h 18m Theory classes: 8h Practical classes: 3h Laboratory classes: 2h Guided activities: 1h 18m Self study: 15h

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Description:
Theory classes, problems and lab corresponding to topic 4

Specific objectives:
2, 3, 4, 6, 7, 8, 9, 10

Topic 5	Hours: 17h 06m Theory classes: 3h Practical classes: 1h Laboratory classes: 2h Guided activities: 1h 06m Self study: 10h

Description:
Theory classes and problems corresponding to topic 5

Specific objectives:
3, 4, 5, 6, 7, 8, 9, 10

Topic 6	Hours: 15h 06m Theory classes: 3h Practical classes: 1h Laboratory classes: 0h Guided activities: 1h 06m Self study: 10h

Description:
Theory classes and problems corresponding to topic 6

Specific objectives:
2, 3, 4, 6, 7

Topic 7	Hours: 33h 12m Theory classes: 8h Practical classes: 3h Laboratory classes: 4h Guided activities: 1h 12m Self study: 17h

Description:
Theory classes, problems and lab corresponding to topic 7

Specific objectives:
1, 2, 3, 6, 7, 8, 9, 10

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Qualification system

The final grade of the course is obtained from:

- The mid-term exam: P (25%)
- The final exam:F (60%)
- Practices:L (15%)

grade= max (0.6F+0.25P+0.15L ; 0.85F+0.15L)

In case of taking a Re-evaluation exam, the final grade is:

grade=0,85R+0,15L

Bibliography

Basic:

Haykin, S.S.; Van Veen, B. Señales y sistemas. Limusa, 2001. ISBN 9681859146.

Oppenheim, A.V.; Willsky, A.S. Señales y sistemas. 2a ed. Prentice-Hall Hispanoamericana, 1997. ISBN 970170116X.

Gonzalez, R.C.; Woods, R.E. Digital image processing. Fouth ed., Global ed. Pearson, 2018. ISBN 9781292223049.

Complementary:

Oppenheim, A.V.; Schafer, R.W. Discrete-time signal processing. 3rd ed. Prentice-Hall, 2010. ISBN 9780131988422.

Vallverdú, S.; Mariño, J.B.; Rodríguez, J.A.; Moreno, A. Tratamiento digital de la señal: una introducción experimental [on line]. 3a ed. Edicions UPC, 1999Available on: <http://hdl.handle.net/2099.3/36344>. ISBN 8483012928.