

Course guide 270211 - SIS - Signals and Systems

 Last modified: 19/07/2023

 Unit in charge:
 Barcelona School of Informatics

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

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

 Academic year: 2023
 ECTS Credits: 6.0
 Languages: Catalan, Spanish

LECTURER

Coordinating lecturer:	OLGA MUÑOZ MEDINA
Others:	Primer quadrimestre: ORESTES MIQUEL MAS CASALS - 11, 12, 13 OLGA MUÑOZ MEDINA - 11, 12, 13

PRIOR SKILLS

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

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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.

Basic:

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

TEACHING METHODOLOGY

The course is based on face-to-face theory, problems and laboratory classes.

The theory classes follow the program defined in this teaching guide. Within the theory and problems 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 signals. They are based on computer programs and are guided by a text.

Theory and problems classes will be in Spanish. Labs will be in Catalan.



LEARNING OBJECTIVES OF THE SUBJECT

1. The student must be able to understand and be proficient in the basic concepts of signals, linear systems, and related functions and transformations.

2. The student must know how to do the mathematical analysis of signals and systems in the time domain, for both analog and digital environments.

3. The student must know how to do the mathematical analysis of analog signals and systems in the frequency domain.

4. The student must know how to do the mathematical analysis of discrete-time signals and systems in the frequency domain.

5. The student must be able to evaluate discrete filters and apply them to real systems

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. The student must know how to interpret and use discrete signals and systems in 1D and 2D in the temporal/spatial.

8. The student must be able to apply the frequency representation of signals and systems to solve various applications.

9. The student must know how to identify, model, and solve problems from open situations. Also, to explore and apply the alternatives for resolution. The student will work with approximations.

10. 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.

11. The student should know additional tools useful for processing discrete generic signals in the time and transformed domains.

12. The student must be able to evaluate the advantages and disadvantages of different technological alternatives to implement analysis systems for analog and discrete signals.

STUDY LOAD

Туре	Hours	Percentage
Hours small group	30,0	20.00
Self study	90,0	60.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Signals and systems in temporal (or spatial) domain

Description: Continuous-domain and discrete-domain signals and systems. Convolution. Linear and time invariant systems. Correlation.

Continuous-Time signals and systems in the frequency domain

Description:

Continuous-Time Fourier Transform (CTFT). Sampling and reconstruction.

Discrete-Time signals and systems in the frequency domain

Description:

Discrete-Time Fourier Transform (DTFT). Frequency analysis of discrete-time signals and systems. Decimation and interpolation. Discrete Fourier Transform (DFT).



Representation, analysis and design of linear filters

Description: Z Transform. Linear filters design.

ACTIVITIES

Analog and digital signals and systems

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

2,6

Related competencies :

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.

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. 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.

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

Full-or-part-time: 8h Theory classes: 2h Practical classes: 2h Self study: 4h

Convolution

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

1, 2, 6

Related competencies :

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Full-or-part-time: 8h

Theory classes: 2h Practical classes: 2h Self study: 4h



Linear and Time-Invariant systems

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives: 1, 2, 6

Related competencies :

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.

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. 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.

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Full-or-part-time: 8h

Theory classes: 2h Practical classes: 2h Self study: 4h

Correlation

Description:

Attendance to lecture and problems session. Solving problems at home.

Specific objectives:

1, 2, 6

Related competencies :

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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. 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.

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

Full-or-part-time: 8h Theory classes: 2h

Practical classes: 2h Self study: 4h



Continuous-Time Fourier Transform (CTFT)

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

3,6

Related competencies :

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.

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. 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.

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Full-or-part-time: 6h

Theory classes: 2h Self study: 4h

Sampling and reconstruction. Teorema de Nyquist

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

2, 3, 6

Related competencies :

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.

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Full-or-part-time: 8h Theory classes: 2h

Practical classes: 2h Self study: 4h



Discrete-Time Fourier Transform (DTFT)

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

4,6

Related competencies :

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.

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

Full-or-part-time: 8h

Theory classes: 2h Practical classes: 2h Self study: 4h

Frequency analysis of time-discrete signals and systems

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

4,6

Related competencies :

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.

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. 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.

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Full-or-part-time: 8h Theory classes: 2h Practical classes: 2h Self study: 4h



Decimation and interpolation

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives: 2, 4, 6

Related competencies :

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.

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

Full-or-part-time: 8h

Theory classes: 2h Practical classes: 2h Self study: 4h

Discrete-Time Fourier Transform (DFT)

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

4,6

Related competencies :

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.

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. 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.

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Full-or-part-time: 9h Theory classes: 3h

Practical classes: 2h Self study: 4h



Z Transform

Specific objectives:

11, 12

Related competencies :

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

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.

Full-or-part-time: 8h

Theory classes: 2h Practical classes: 2h Self study: 4h

Filters design

Description:

Attendance to lecture and problems session. Independent work on proposed problems.

Specific objectives:

5,8

Related competencies :

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.

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

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.

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

Full-or-part-time: 6h Theory classes: 2h

Self study: 4h



Lab: convolution and correlation

Description:

Lab

Specific objectives:

5, 7, 9, 10

Related competencies :

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.

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Full-or-part-time: 4h

Practical classes: 2h Self study: 2h

Lab: vocoder

Description:

Lab

Specific objectives:

5, 7, 9, 10

Related competencies :

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.

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.

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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.

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Full-or-part-time: 4h Practical classes: 2h

Self study: 2h



Lab: analysis of basic signals in the frequency domain

Description:

Lab

Specific objectives:

8,10

Related competencies :

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

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.

Full-or-part-time: 4h

Practical classes: 2h Self study: 2h

Lab: frequency analysis of speech signals

Description:

Lab

Specific objectives:

8,10

Related competencies :

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

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.

Full-or-part-time: 4h Practical classes: 2h Self study: 2h



Lab: pre-processing of noisy ECGs

Description:

Lab

Specific objectives:

5, 8, 10

Related competencies :

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.

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.

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vision, speech recognition and multimedia data processing.

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.

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Full-or-part-time: 4h

Practical classes: 2h Self study: 2h

Mid-term exam

Specific objectives:

1, 2, 3, 6, 7, 8

Related competencies :

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.

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.

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vision, speech recognition and multimedia data processing. 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.

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Full-or-part-time: 10h Guided activities: 2h Self study: 8h



Final exam

Specific objectives: 1, 2, 3, 4, 6, 7, 8

Related competencies :

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.

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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.

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

Full-or-part-time: 18h

Guided activities: 3h Self study: 15h

Test 1

Specific objectives:

2

Related competencies :

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.

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

Full-or-part-time: 3h

Self study: 3h

Test 2

Specific objectives:

3

Related competencies :

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.

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

Full-or-part-time: 3h Self study: 3h



Test 3

Specific objectives:

4

Related competencies :

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.

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Full-or-part-time: 3h Self study: 3h

GRADING SYSTEM

The final grade of the course is obtained from:

- Quizzes: Q (6%)

- The mid-term exam: P (19%)
- The final exam: F (60%)

- Lab: L (15%)

Final grade = max(0.19 P + 0.06 Q + 0.15 L + 0.6 F; 0.15 L + 0.85 F)

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

Final grade = 0.85 R+0.15 L

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.

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. 3a ed. Edicions UPC, 1999. ISBN 8483012928.