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.
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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 30h</th>
<th>20.00%</th>
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</thead>
<tbody>
<tr>
<td>Hours small group: 30h</td>
<td>20.00%</td>
<td></td>
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<tr>
<td>Guided activities: 0h</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Self study: 90h</td>
<td>60.00%</td>
<td></td>
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</tbody>
</table>
# Signals and Systems

## Fourier transform of analog signals.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Definition and properties.</td>
</tr>
<tr>
<td>Frequency response.</td>
</tr>
<tr>
<td>Examples: Filtering, packaging, modulation.</td>
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</tbody>
</table>

## Sampling.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
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<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Sampling Theorem.</td>
</tr>
<tr>
<td>Interpolation formula.</td>
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<tr>
<td>Conversion A/D, D/A.</td>
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</table>

## Fourier transform of discrete signals.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
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<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Definition and Properties</td>
</tr>
<tr>
<td>Discrete Fourier Transform. DFT-1D.</td>
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</table>

## Filtering.

<table>
<thead>
<tr>
<th>Degree competences to which the content contributes:</th>
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<tbody>
<tr>
<td>Description:</td>
</tr>
<tr>
<td>Z transform.</td>
</tr>
<tr>
<td>Linear phase filters, filters runs all over.</td>
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</tbody>
</table>
### 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.
## Planning of activities

| Topic 1 | Hours: 22h 06m  
Theory classes: 8h  
Practical classes: 3h  
Laboratory classes: 0h  
Guided activities: 1h 06m  
Self study: 10h |
<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes and problems corresponding to topic 1</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 6</td>
</tr>
</tbody>
</table>

| Topic 2 | Hours: 15h 06m  
Theory classes: 3h  
Practical classes: 1h  
Laboratory classes: 0h  
Guided activities: 1h 06m  
Self study: 10h |
<table>
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes and problems corresponding to topic 2</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 4, 6, 7</td>
</tr>
</tbody>
</table>

| Topic 3 | Hours: 15h 06m  
Theory classes: 3h  
Practical classes: 1h  
Laboratory classes: 0h  
Guided activities: 1h 06m  
Self study: 10h |
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<tbody>
<tr>
<td><strong>Description:</strong></td>
<td>Theory classes and problems corresponding to topic 3</td>
</tr>
<tr>
<td><strong>Specific objectives:</strong></td>
<td>1, 2, 3, 4, 6, 7</td>
</tr>
</tbody>
</table>

| Topic 4 | Hours: 29h 18m  
Theory classes: 8h  
Practical classes: 3h  
Laboratory classes: 2h  
Guided activities: 1h 18m  
Self study: 15h |
| --- | --- |
## Description:
Theory classes, problems and lab corresponding to topic 4

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

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

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### Topic 5

### Description:
Theory classes and problems corresponding to topic 5

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

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

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### Topic 6

### Description:
Theory classes and problems corresponding to topic 6

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

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

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### Topic 7

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

### Specific objectives:
1, 2, 3, 6, 7, 8, 9, 10
The final grade of the course is obtained from:

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

\[ \text{grade} = \max (0.6F + 0.25P + 0.15L ; 0.85F + 0.15L) \]

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

\[ \text{grade} = 0.85R + 0.15L \]

**Bibliography**

**Basic:**


**Complementary:**