320102 - SS - Signals and Systems

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications
Academic year: 2018
Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan

Teaching staff
Coordinator: XAVIER GIRÓ I NIETO
JAVIER VILLARES PIERA
Others: XAVIER GIRÓ I NIETO
JAVIER VILLARES PIERA
SISCO VALLVERDÚ BAYES

Opening hours
Timetable: Contact the professor by e-mail providing your availability during a week.

Prior skills
Calculus and graphical representation of functions.

Requirements
Students wishing to take this subject are strongly recommended to have passed the mathematics subjects in previous years.

Degree competences to which the subject contributes

Specific:
3. AUD_COMMON: Ability to analyse and specify the fundamental parameters of a communication system.
4. AUD_COMMON: Ability to get new knowledge and to learn new techniques appropriate to the conception, development and exploitation of telecommunication systems and services.

Transversal:
1. SELF-DIRECTED LEARNING - Level 2: Completing set tasks based on the guidelines set by lecturers. Devoting the time needed to complete each task, including personal contributions and expanding on the recommended information sources.
2. EFFECTIVE USE OF INFORMATION RESOURCES - Level 2. Designing and executing a good strategy for advanced searches using specialized information resources, once the various parts of an academic document have been identified and bibliographical references provided. Choosing suitable information based on its relevance and quality.
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Teaching methodology

- Face-to-face lecture sessions.
- Face-to-face laboratory sessions.
- Face-to-face problem-solving sessions.
- Independent learning and exercises.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and use examples to facilitate students' understanding.

In the face-to-face laboratory sessions, students will use software that exemplifies the concepts covered by the topic. Students will resolve problems visually and interactively using these programs. They can also use these programs in online study. Students will complete face-to-face programming exercises using the MATLAB programming language.

In classroom-based face-to-face problem-solving exercises, the lecturer will guide students in data analysis and problem resolution applying theoretical techniques, concepts and results.

Students will work autonomously on assimilating the concepts, using their own notes taken in theory classes and the compulsory and recommended reading lists. It is especially important for students to complete the assignments set in class and those included in the set of problems for the subject.

Learning objectives of the subject

Acquire an understanding of the basic set of tools and concepts that enable observations of the physical world to be modelled using system-processed signals. The course will focus on signals that depend on a single variable and on their processing in linear time-invariant systems. The theory and assignments will enable the resolution of basic problems associated with time and frequency representation of signals and signal systems. The studied concepts will be applied in subsequent courses covering signal design, signal analysis and audio, video and communication systems.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
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<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>10.00%</td>
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<td></td>
<td>Guided activities: 0h</td>
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<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
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</table>
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### Content

<table>
<thead>
<tr>
<th>TOPIC 1: CONTINUOUS SIGNALS AND SYSTEMS</th>
<th>Learning time: 32h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 10h</td>
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<tr>
<td></td>
<td>Practical classes: 0h</td>
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<tr>
<td></td>
<td>Laboratory classes: 3h</td>
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<tr>
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<td>Self study: 19h</td>
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### Description:
1.1. Introduction.
1.2. Transformations of the independent variable.
1.3. Basic continuous signals.
1.4. System properties.
1.5. Linear time-invariant systems.
1.6. Impulse response.
1.7. Convolution integral.
1.8. System interconnection.

### Specific objectives:
For students to:
- Acquire general information on course content.
- Understand and draw basic signals.
- Confidently handle transformations of the independent variable.
- Classify continuous systems according to their properties.
- Understand the significance of the convolution integral.
- Efficiently calculate both analytical and graphical convolutions.
- Learn to represent system behaviour as a block diagram.
TOPIC 2: CONTINUOUS SIGNALS AND SYSTEMS IN THE TRANSFORM DOMAIN

Learning time: 32h
- Theory classes: 10h
- Practical classes: 0h
- Laboratory classes: 3h
- Self study: 19h

Description:
2.3. Fourier transforms of periodic signals.
2.4. Characterisation of a system according to its frequency response.
2.5. Relationship between the properties of a system and its frequency response.
2.6. Convolution theorem.
2.7. Filters.

Specific objectives:
For students to:
- Capture the significance of the representation of signals according to a base.
- Understand that signal information can be represented in both the time and frequency domains.
- Obtain the coefficients for serial Fourier representation of periodic signals and interpret their values.
- Understand FT properties.
- Calculate an FT signal from the FT of other signals and FT properties.
- Analyse a linear time-invariant system in the frequency domain, bearing in mind the relationship with the time domain.
- Study FT applications.
### TOPIC 3: DISCRETE SIGNALS AND SYSTEMS

<table>
<thead>
<tr>
<th>Learning time: 30h</th>
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<tbody>
<tr>
<td>Theory classes: 9h</td>
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<tr>
<td>Practical classes: 0h</td>
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<tr>
<td>Laboratory classes: 3h</td>
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<tr>
<td>Self study: 18h</td>
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</tbody>
</table>

**Description:**
- 3.1. Introduction.
- 3.2. Transformations of the independent variable.
- 3.3. Basic discrete signals.
- 3.4. System properties.
- 3.5. Linear time-invariant systems.
- 3.6. Impulse response.
- 3.7. Discrete convolution.
- 3.8. System interconnection.
- 3.9. Systems defined by finite difference equations (FDEs).

**Specific objectives:**
For students to:
- Express and draw basic discrete signals and signals resulting from transformations of the independent variable.
- Analyse the periodicity of a discrete signal.
- Study the properties of discrete systems.
- Calculate impulse response for a linear time-invariant system.
- Calculate the convolution of two discrete signals.
- Calculate the impulse response for interconnected linear time-invariant systems.
### TOPIC 4: DISCRETE SIGNALS AND SYSTEMS IN THE TRANSFORM DOMAIN

**Learning time:** 33h  
Theory classes: 10h  
Practical classes: 0h  
Laboratory classes: 4h  
Self study: 19h

<table>
<thead>
<tr>
<th>Description:</th>
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<tbody>
<tr>
<td>4.1. Introduction.</td>
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<tr>
<td>4.2. Z-transform (ZT). Region of convergence (ROC).</td>
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<tr>
<td>4.3. Z-transform of basic signals.</td>
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<td>4.4. Inverse Z-transform.</td>
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<td>4.5. Z-transform properties.</td>
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<td>4.7. Analysis of systems defined by FDEs.</td>
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<tr>
<td>4.8. Fourier transform (FT) of discrete signals.</td>
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<tr>
<td>4.9. Properties of the FT.</td>
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<td>4.10. Discrete Fourier transform (DFT).</td>
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**Related activities:**  
Activity 2, Activity 3.

**Specific objectives:**  
For students to:  
- Calculate the Z-transform and its region of convergence for basic signals.  
- Calculate the ZT for a sequence from the properties of the Z-transform and the transforms for known signals.  
- Relate the causality of a sequence with the ROC for its Z-transform.  
- Calculate the transfer function for a system defined by an FDE.  
- Relate the ROC and the pole-and-zero plot with the stability and causality properties of a system.  
- Calculate the FT for basic signals.  
- Apply FT properties.  
- Relate the FT for a discrete signal with the DFT.
# TOPIC 5: SAMPLING

### Description:

5.1. Introduction.
5.2. Sampling and reconstruction.
5.3. Sampling theorem.
5.4. Aliasing.
5.5. A/D and D/A conversion.
5.6. DELMAT and interpolation.

### Specific objectives:

For students to:
- Select a suitable sampling frequency for each application.
- Understand the conditions in which it is possible to reconstruct a signal from a set of samples.
- Understand aliasing and strategies to prevent it.
- Interpret DELMAT and interpolation in time and transform domains.

### Learning time:

23h
- Theory classes: 6h
- Practical classes: 0h
- Laboratory classes: 2h
- Self study: 15h
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Planning of activities

**PROBLEMS AND LAB EXERCICIES**

**Hours:** 37h  
Laboratory classes: 15h  
Self study: 22h

**Description:**  
Solving problems and lab sessions related to the content of the course.

**Descriptions of the assignments due and their relation to the assessment:**  
Solution of lab assignments and tests, they correspond to the 30% of the final grade of the course.

**EXAM 1**

**Hours:** 72h  
Theory classes: 21h  
Self study: 51h

**Description:**  
Individual test in the classroom, related to objectives learnt in topics 1 and 2.

**Descriptions of the assignments due and their relation to the assessment:**  
Resolution of the test represents 25% of the final mark.

**EXAM 2**

**Hours:** 71h  
Theory classes: 21h  
Self study: 50h

**Description:**  
Individual test in the classroom, related to objectives learnt of the course.

**Descriptions of the assignments due and their relation to the assessment:**  
Resolution of the test represents 45% of the final mark.

Qualification system

1st evaluation (exam): 25%  
2nd evaluation (exam): 45%  
Laboratory: 30%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.

If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.
Bibliography

Basic:


Complementary:

