



Course guide

320102 - SS - Signals and Systems

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 739 - TSC - Department of Signal Theory and Communications.

Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: EDUARDO BERTRAN ALBERTI

Others:

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:

CE06-ESAUD. Ability to autonomously learn new knowledge and techniques suitable for the conception, development, or exploitation of telecommunications systems and services. (Common module for the telecommunications branch)

CE09-ESAUD. Ability to analyze and specify the fundamental parameters of a communications system. (Common module for the telecommunications branch)

Generical:

CG03-ESAUD. Knowledge of basic subjects and technologies, which enables learning of new methods and technologies, as well as providing great versatility to adapt to new situations.

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

Type	Hours	Percentage
Self study	90,0	60.00
Hours small group	15,0	10.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

TOPIC 1: CONTINUOUS SIGNALS AND SYSTEMS

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.

Full-or-part-time: 32h

Theory classes: 10h

Laboratory classes: 3h

Self study : 19h



TOPIC 2: CONTINUOUS SIGNALS AND SYSTEMS IN THE TRANSFORM DOMAIN

Description:

- 2.1. Representation of periodic signals: Fourier series. Definition and convergence.
- 2.2. Representation of non-periodic signals: Fourier transform (FT). Properties.
- 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.

Full-or-part-time: 32h

Theory classes: 10h

Laboratory classes: 3h

Self study : 19h

TOPIC 3: DISCRETE SIGNALS AND SYSTEMS

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.

Full-or-part-time: 30h

Theory classes: 9h

Laboratory classes: 3h

Self study : 18h



TOPIC 4: DISCRETE SIGNALS AND SYSTEMS IN THE TRANSFORM DOMAIN

Description:

- 4.1. Introduction.
- 4.2. Z-transform (ZT). Region of convergence (ROC).
- 4.3. Z-transform of basic signals.
- 4.4. Inverse Z-transform.
- 4.5. Z-transform properties.
- 4.6. Analysis and characterisation of linear time-invariant systems using the Z-transform.
- 4.7. Analysis of systems defined by FDEs.
- 4.8. Fourier transform (FT) of discrete signals.
- 4.9. Properties of the FT.
- 4.10. Discrete Fourier transform (DFT).

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.

Related activities:

Activity 2, Activity 3.

Full-or-part-time: 33h

Theory classes: 10h

Laboratory classes: 4h

Self study : 19h

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.

Full-or-part-time: 23h

Theory classes: 6h

Laboratory classes: 2h

Self study : 15h



ACTIVITIES

PROBLEMS AND LAB EXERCICIES

Description:

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

Delivery:

Solution of lab assignments and tests, they correspond to the 30% of the final grade of the course.

Full-or-part-time: 37h

Laboratory classes: 15h

Self study: 22h

EXAM 1

Description:

Individual test in the classroom, related to objectives learnt in topics 1 and 2

Delivery:

Resolution of the test represents 25% of the final mark.

Full-or-part-time: 72h

Theory classes: 21h

Self study: 51h

EXAM 2

Description:

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

Delivery:

Resolution of the test represents 45% of the final mark.

Full-or-part-time: 71h

Theory classes: 21h

Self study: 50h

GRADING 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:

- Oppenheim, Alan V. Signals and systems. 2nd ed. Englewood Cliffs: Prentice-Hall, 1997. ISBN 0136511759.
- Mariño, J. B. Tratamiento digital de la señal: una introducción experimental [on line]. 3a ed. Barcelona: Edicions UPC, 1999 [Consultation: 11/01/2016]. Available on: <http://hdl.handle.net/2099.3/36344>. ISBN 8483012928.
- Sayrol, Elisa; Gassull, A. Senyals i sistemes analògics: una introducció pràctica [on line]. 2a ed. Barcelona: Edicions UPC, 2002 [Consultation: 14/05/2020]. Available on: <http://hdl.handle.net/2099.3/36511>. ISBN 8483016109.

Complementary:

- Oppenheim, A. V. Discrete-time signal processing. 2nd ed. Upper Saddle River: Prentice-Hall, 1999. ISBN 0137549202.
- Jackson, Leland B. Signals, systems and transforms. Reading: Addison-Wesley, 1991. ISBN 0201095890.
- Proakis, John G. Introduction to digital signal processing. New York: MacMillan: MacMillan, 1988. ISBN 0029462533.