Teaching Plan for the Subject

Educational Guide

1. Descriptive data of the subject

Academic course: 2011-12

Name of the subject: Signals and Systems

Subject code: 21409, 21720, 21598
Degree: Bachelor's degree in Computer Engineering,
Bachelor's degree in Telecommunications Network Engineering,
Bachelor's degree in Audiovisual Systems Engineering

ECTS Credits: 8
Hours of dedication: 200 hours
Teachers: Xavier Serra, Vicent Caselles, Azadeh Faridi
Groups: 1 and 2

2. Presentation of the subject

This is an introductory course in the digital processing of the signal designed for students of the second academic year of computer engineering, Telematics, and Audiovisual Systems. The course aims to enable students to understand the basic mathematical concepts used in the study of digital signals and systems and who know how to use these concepts in specific engineering problems.

The course syllabus includes a more mathematical part and one more focused on the processing of the signal from an engineering point of view. Among the most mathematical subjects, the study of complex numbers, the discrete Fourier transformation and the Z transformation are included. In the most focused part of signal processing, the study of sinusoidal signals, sampling and its spectral representation, and the study of digital filters, both FIR and IIR.

The course is organized methodologically in three types of teaching activities, lectures or theoretical classes, seminars, and laboratories or practical classes. In lectures, the teacher explains the theoretical concepts of the syllabus. In the seminars, where the teacher works with small groups of students, they discuss and solve problems related to each of the topics addressed in the master classes with the active participation of students.
Finally, in the laboratories, which take place in computer rooms, students carry out programming practices under the supervision of the teacher. In these practices, algorithms are designed and implemented related to each of the signal processing concepts that are dealt with in the course.

3. Skills to achieve in the subject

Skills to work on the subject as indicated in the educational guide.

<table>
<tr><th>Transversal competences</th><th>Specific competences</th></tr>
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Instrumental

1. Capacity for analysis and synthesis.
2. Troubleshooting.
3. Oral and written communication.

Interpersonal

1. Teamwork.
2. Capacity for criticism and self-criticism.

Systemic

1. Ability to integrate knowledge and methodologies into practice.
2. Concern for quality.

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1. Understand and know how to use the appropriate mathematical concepts to analyze and represent signals and digital systems.
2. Understand the sinusoidal signals from the mathematical point of view, as well as signal processing, as well as from the physical.
3. Understand the mathematics of the Fourier Transform and its properties.
4. Understand the concept of spectral representation and its use to represent temporal signals.
5. Know how to convert continuous time signals into discrete time signals and vice versa. Understand the Shannon sampling theorem and the aliasing and folding phenomena.
6. Understand and know how to use the Z transformation in the study of digital systems.
7. Understand and know how to use the different representations of the FIR and IIR filters: Equation of differences, Impulse response, Frequency response, and Transfer function.
8. Understand the methods of spectral analysis for periodic and non-discrete time signals. Know how to interpret the spectral representation and know how to identify the spectral characteristics of the signals.
9. Know how to design and implement audio processing algorithms.

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4. Contents

List of contents, organized by blocks.

b. Answer in the temporary domain
c. Function of the IIR filter system
d. Powder and zeros
e. Frequency response of an IIR filter
f. The three domains
g. Reverse Z transformation and applications
h. Responding to a stable state and stability
i. Second order filters
j. Frequency response of second order filters
k. Example of a low-pass IIR filter

Block 9. Continuous temporal signals and LTI systems

a. Continuous time signals
b. Impulsional signal
c. Temporary contiguous systems
d. Linear and invariant systems in time
e. Impulse response of basic LTI systems
f. Convolution of impulses
g. Evaluation of the convolution integral
h. Properties of LTI systems

Block 10. Continuous Fourier transform

a. Definition of the Fourier transform
b. Fourier transform and spectrum
c. Existence and convergence of the Fourier transform
d. Examples of Fourier pairs
e. Properties of Fourier pairs
f. Property of Convolution
g. Basic LTI systems
h. Table of properties of the Fourier transform
i. Properties of LTI systems

Block 11. Filtration, modulation and sampling

a. Linear and invariant systems in time
b. Modulation of amplitude of sinusoids
c. Sampling and reconstruction

Block 12. Calculating the spectrum

a. Finished sum of Fourier
b. Fourier transformed masses
c. Temporary window
d. Analysis of a sum of sinusoids
e. Discrete Fourier Transform
f. Spectral analysis of finite signals
g. Spectral analysis of periodic signals
h. The spectrogram
i. Fourier transform of short time, STFT

5. Evaluation of the level of achievement of competences

The course is organized into three types of teaching activities: master classes of theory, seminars and practices / laboratories. The final grade is the result of combining a continuous assessment with two partial exams and one final exam. The final exam includes the recovery of both partial and a new part. If the first two partial examinations are approved, you do not have to take the final exam of these parts, only voluntarily to raise a note.

Following is the evaluation of each activity:

- Theory (17 punts)
  - First partial exam, week 8 of the first quarter (5 points)
  - Second partial exam, week 6 of the second quarter (7 points)
  - Final examination of both partial (6 points) and third partial (5 points)
- Laboratories (9 punts)
  - Delivery reports (1 punts)
  - First partial exam, week 8 of the first quarter (2 punt)
  - Second partial exam, week 6 of the second quarter (5 punts)
  - Final examination of both partial (4 points) and third partial (1 punts)
- Seminars (8 punts)
  - Tests in class

The final grade is calculated as follows:

Mark = 10 * (Theory + Labs + Seminars)/34

There are two partial and one final written and individual examinations to evaluate the comprehension of the contents presented in theory classes and reinforced with the seminars and laboratories. This evaluation is mandatory and must be rated at least 50% in order to pass the subject. If both partial examinations are approved, in the final exam only one third of the subject that has not been evaluated in the partial examinations has to be done. The student can choose to complete the final exam to upload the partial exams.

Before each laboratory, the statement of the exercises will be presented during the practice. During the laboratories the students solve practical problems and implement algorithms with Octave and / or Matlab. The practices are delivered through Moodle individually at the end of each type of internship. The assessment is based on the practices delivered and from a written test that is carried out in conjunction with the partial and final exams. This assessment is also mandatory and must be qualified at least 50% in order to pass the subject.

Before each seminar, a collection of problems is given to students so that they work individually before the session, as a pre-seminar preparation. These problems correspond to concepts or knowledge treated in the theory class and put into practice in laboratories. During the seminar, all students must participate in the resolution of a selection of problems previously given. The evaluation of this activity is based on the individual exercises that the teacher determines and which are done during the classes.

6. Bibliography and didactic resources

6.1. Basic bibliography

- James H. McClellan, Ronald W. Schafer, and Mark A. Yoder, 2003. Signal Processing First (SPF). Prentice Hall, International edition

6.2. Complementary bibliography

- A. V. Oppenheim and R. W. Schafer. 1999. Discrete-Time Signal Processing. Prentice Hall.
- John G. Proakis and Dimitris G. Manolakis. 1998. Tratamiento digital de señales. Prentice Hall.
- C. Sidney Burrus et al. 1998. Ejercicios de Tratamiento de la Señal utilizando matlab v.4. Prentice-Hall.

6.3. Didactic resources

- Resources related to SP First: http://users.ece.gatech.edu/mcclella/SPFirst/
- A collection of problems in the Moodle of the subject is available for each seminar session.
- For each practice session the practice statement is available in Moodle of the subject.

7. Methodology

Content blocks	Hours in the classroom			Hours outside the classroom	
	Big Group (Theory)	Medium Group (Lab)	Small group (Seminar)		
Block 1	1	---	---	1	
Block 2	3	2	2	8	
Block 3	4	2	2	10	
Block 4	2	---	1	4	
Exam 1			1	15	
Block 5	4	4	2	12	
Block 6	2	---	1	4	
Block 7	2	2	1	6	
Block 8	4	2	2	10	
Block 9	2	2	1	6	
Exam 2			1	15	
Block 10	4	---	2	8	
Block 11	2	---	1	4	
Blok 12	4	2	1	10	
Final Exam	2			17	
Total	36	16	18	130	# Total hours 200

8. Programming of activities

1. Programming of face-to-face sessions

Set.	Theory	Seminar	Laboratory	Exams
First Trimester				
1	Introduction to Signals and Systems (1) Sinusoids and Exponential (1)			
2	Sinusoids and Exponential (2)	Sinusoids and Exponential (1)		
3	Spectral representation (2)	Sinusoids and Exponential (1)	Intro to Octave and Sinusoides (2)	
4	Spectral representation (2)	Spectral representation (1)		
5	Sampling and Aliasing (2)	Spectral representation (1)	Spectral representation (2)	
6	FIR Filters (2)	Sampling and Aliasing (1)		
7		FIR Filters (1)		
8		review (1)		First midterm exam
9	FIR Filters (2)		FIR Filters (2)	
10	Freq response FIR (2)	FIR Filters (1)		
11	Transformed Z (2)	Freq response FIR (1)	FIR Filters (2)	
Second Trimester				
1	IIR Filters (2)	Transformed Z (1)	Transformed Z (2)	
2	IIR Filters (2)	IIR Filters (1)		
3	Continual Signals (2)	IIR Filters (1)	IIR Filters (2)	
4	Fourier Transform (2)	Continuous Signals (1)		
5	Fourier Transform (2)	review (1)		
6			Continuous Signals (2)	Second midterm exam
7	Filtering, modulation (2)	Fourier Transform (1)		
8	Calculating the spectrum (2)	Fourier Transform (1)		
9	Calculating the spectrum (2)	Filtering, modulation (1)		
10	review (2)	Filtering, modulation (1)	Calculating the spectrum (2)	
				Final