COURSE DATA

Data Subject	
Code	34907
Name	Digital Speech and Audio Processing
Cycle	Grade
ECTS Credits	6.0
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1403 - Degree in Telematics Engineering	School of Engineering	4	Second term

Subject-matter

Degree	Subject-matter	Character
1403 - Degree in Telematics Engineering	19 - Optional subjects	Optional

Coordination

Name	Department
COBOS SERRANO, MAXIMO	240 - Computer Science

SUMMARY

The course "Digital audio and speech processing" is a fourth-year course that is part of the optional block of subjects in the “Grado en Ingeniería Telemática”. The course complements the contents seen in other subjects of the degree, such as "Procesado Digital de Señal", "Señales y Sistemas Lineales" and "Fundamentos Matemáticos de las Comunicaciones", providing an applied overview of the concepts studied throughout these courses. Thus, the topics covered by this course are oriented to the implementation of digital signal processing systems in the field of audio and speech applications.

The course justifies the importance of audio signal processing in current multimedia systems, reviewing briefly some basic concepts studied in previous years. The contents are structured following an approach where more threoretical concepts are introduced in the first part of the course, paving the way to other lessons that make use of such concepts in current practical systems. Thus, the course starts by reviewing basic signal processing concepts, as well as other relevant points in audio such as sampling, quantization, short-time analysis/synthesis or statistical signal processing methods. The theoretical part is complemented by the study of the human hearing system and its impact in the design of practical lossy audio coding systems, the human vocal system and the source/filter model widely used in speech coding. Concepts such as optimal filtering, linear prediction or subband analysis are introduced froma practical perspective.

The aim of the course is to provide the students with an applied overview of the concepts studied along the degree, facilitating the understanding of abstract terms by studying specific multimedia applications, such as MP3 audio coding. Thus, it is intended that students get a practical view of random variables and random processes, Fourier transforms and their applications, or information theory.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

OUTCOMES

LEARNING OUTCOMES

This course allows for the following key learning outcomes. Note that since this course is optional, there are not specific competencies linked to these learning outcomes.

-Acquire new knowledge and techniques suitable for the design, development and implementation of telecommunication systems, especially those related to multimedia communications.

-Follow the design process of systems based on auditory perception, relating the aspects involved in it with the associated mathematical theory.

In addition to the above results, this subject also allows to acquire the following technical and social skills:

-Apply the knowledge on auditory perception to the design of signal processing systems.

-Identify the limitations in the analog / digital conversion of audio signals.

-Select properly the parameters needed for the encoding and storage of audio and speech signals.

-Identify the models that guide the design of existing telecommunication systems.

-Implement basic signal processing systems oriented to audio processing.

-Adequately describe the principles ofaudio signal compression, relating them to the corresponding physical and mathematical theories.

-Promote teamwork and organization into tasks and subtasks.

DESCRIPTION OF CONTENTS

0. Introduction

Digital audio, image and video processing overview. Signal processing in multimedia.

1. Signal processing review

Descripción de contenidos (English):
Introduction. Review of convolution and filtering. Sampling theorem. Discrete-time signal processing. DFT and DTFT. Random processess.

2. Audio and psychoacoustic principles

Descripción de contenidos (English):
Introduction. Fundamentals of Acoustics. Hearing and perception. Loudness and critical bands.

3. Quantization and conversion

Descripción de contenidos (English):
Introduction. Scalar quantization. Entropy coding. Dither and Noise Shaping. Oversampling.

4. Audio analysis and synthesis

Introduction. Short-time Fourier Transform. Filter Banks. Overlap-add filtering.

5. Coding

Introduction. Linear prediction. Sub-band and transform coding. MPEG Audio.

6. Audio signal processing applications

Noise reduction, sound source localization, 3D audio.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	30,00	100
Laboratory practices	20,00	100
Classroom practices	10,00	100
Development of group work	20,00	0
Development of individual work	10,00	0
Preparation of evaluation activities	20,00	0
Preparing lectures	10,00	0
Preparation of practical classes and problem	15,00	0
Resolution of case studies	15,00	0
TOTAL	**150,00**	

TEACHING METHODOLOGY

1) Work at the course:

a) Theory sessions, including short activities for the students.

b) Problem solving sessions, to practice the concepts from the theory sessions.

c) Lab sessions, understanding by means of simulations the most important concepts from the theory sessions.

2) Student's own work:

a) Homework and exposition in class of the solution.

b) Exam preparation.

c) Lab sessions preparation, reading the lab description and the related theoretical concepts.

Consulting sessions: A certain number of hours are established each week, which the students can attend in order to solve doubts.

EVALUATION

The course evaluation follows a modified conventional approach, not reaching a full continuous-time evaluation. The following items are considered:

Attendance to the course lessons and participation (5% of the final mark). This activity is non-recoverable. The mark is saved for the second evaluation.

Result from the 1st exam (20% of the final mark)

Lab sessions (15% of the final mark). This activity is non-recoverable. The mark is saved for the second evaluation.

Homework (15% of the final mark). This activity is non-recoverable. The mark is saved for the second evaluation.

Exam/Project (45% of the final mark)

To evaluate the attendance, the student needs to attend at least 75% of the course lessons.

For the students who cannot attend the course lessons, an alternative evaluation is proposed, where the attendance is replaced by solving additional homework. Students who wish to take this option must notify the teacher during the first 3 weeks of the course.

The last evaluable item (Exam / Project) refers to the possibility that the student chooses between taking a final exam or completing a project proposed by the teacher. The final project includes the programming of signal processing algorithms, a technical report and an oral presentation, as well as a small examination related to the project topic.

The minimum mark required to pass the course is 3.5 over 10 in both the partial exam and the project. The remaining items are not subjected to a minimum.

Both in the first and second evaluation of the course, two options are possible:

- Final exam (65%)

- Final exam (20%/45%). The mark of the partial exam or the project is saved if its higher than 3.5. The part with lowest evaluation can be recovered by taking the exam.

The student must choose this option before taking the second exam.

REFERENCES

Basic

- Zölzer, Udo., Digital Audio Signal Processing, 2nd edition, Wiley, 2008. ISBN: 0470997850
- Pulkki, V., Karjalainen, M. Communication Acoustics: An Introduction to Speech, Audio and Psychoacoustics. Wiley (2015). ISBN: 978-1-118-86654-2

Additional

- -Bosi, M. and Goldberg, Richard E., Introduction to Digital Audio Coding and Standards, Kluwer Academic Publishers, 2003. ISBN: 978-1402073571
  -Smith III, Julius O., Spectral Audio Signal Processing, W3K Publishing, 2011. 978-0974560731

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

The contents initially included in the teaching guide are maintained.

Workload and temporary teaching planning

The different activities described in the teaching guide are maintained with the planned dedication.

The material for the follow-up of the classes of theory/practices allows to continue with the professor of temporary planning so much in days as in schedule, so much if the teaching is face-to-face in the classroom or if it is not.

Teaching methodology

In classroom theory and practices, students will tend to have the maximum physical attendance possible, always respecting the sanitary restrictions that limit the capacity of the classrooms as indicated by the competent public health authorities to the estimated percentage of their usual occupation.

Depending on the capacity of the classroom and the number of students enrolled, it may be necessary to distribute the students into two groups. If this situation arises, each group will attend classroom theory and practical sessions with physical presence in the classroom by rotating shifts, thus ensuring compliance with the criteria for occupying spaces.

The rotation system will be established once the actual enrollment data is known, guaranteeing, in any case, that the attendance percentage of all the students enrolled in the subject is the same.

With respect to laboratory practices, attendance at sessions scheduled in the schedule will be totally face-to-face.

Once the actual enrollment data is available and the availability of spaces is known, the Academic Committee of the Degree will approve the Teaching Model of the Degree and its adaptation to each subject, establishing in said model the specific conditions in which it will be developed teaching the subject.

If there is a closure of the facilities for sanitary reasons that totally or partially affects the classes of the subject, these will be replaced by non-contact sessions following the established schedules.

Evaluation

First call. Weight is specified in percentage on the final grade:

1) Attendance and participation in theory and practical classes (face-to-face or virtual). (5%)

2) Delivery of practical reports. (twenty%)

3) Partial tests at the end of each topic, which can be done electronically. (30%)

4) Exam / Final work, which can be done online (45%)

Second call.

1) Final exam that makes up the attendance, the partial tests and the final exam / work. (80%)

2) Delivery of practical reports (20%) (they must be delivered before the final exam)

If there is a closure of the facilities for health reasons that affect the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the Universitat de València.

Bibliography

The bibliography recommended in the teaching guide.