Universida_{de}Vigo

IDENTIFYING DATA
Sound Processing

Subject	Sound Processing
Code	V05G300V01634
Study programme	Degree in Telecommunications Technologies Engineering

Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	3rd	2nd

Teaching language	Spanish
Department	
Coordinator	Rodríguez Banga, Eduardo
Lecturers	Cardenal López, Antonio José Rodríguez Banga, Eduardo
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General description	This course describes the main techniques of the sound processing, with special emphasis on real applications. Students are shown s the basic principles of these techniques and how the same principles may give rise to different algorithms or systems depending on the type of signal to process (speech or audio, for instance). This course also makes an introduction to the principles of underwater acoustic and ultrasounds as well as their applications.

Competencies

Code	
B4	CG4: The ability to solve problems with initiative, to make creative decisions and to communicate and transmit knowledge and skills, understanding the ethical and professional responsibility of the Technical Telecommunication Engineer activity.
B6	CG6: The aptitude to manage mandatory specifications, procedures and laws.
C34	CE34/SI1The ability to construct, exploit and manage telecommunication services and applications, such as receiving, digital and analogical treatment, codification, transporting and representation, processing, storage, reproduction, management and presentation of audiovisual and multimedia information services.
C37	CE37/SI4 The ability to carry out acoustic engineering projects related to: acoustical isolation and conditioning of rooms, loudspeaker installations, specification, analysis and selection of electro acoustical transducers, measurement, analysis and control of radio vibration systems, environmental acoustics, submarine and acoustical systems.
C38	CE38/SI5 The ability to create, modify, manage, broadcast and distribute multimedia contents taking into account the use and accessibility criteria to audiovisual, broadcasting and interactive services.
D2	CT2 Understanding Engineering within a framework of sustainable development.

Learning outcomes

Expected results from this subject	Training and Learning Results		
Understand the production and perception mechanisms of the sound.	B4		
Understand some basic techniques for sound processing.	B4	C34 C38	
Development of basic speech and audio coders.	B4	C34 C38	
Analyse speech and audio specifications and standards.	B4 B6	C34 C38	
Use of coding standards on concrete applications.	B4 B6	C34 C38	D2
Understand the basic principles of ultrasounds.	B4	C37	
Understand the basic principles of underwater acoustics.	B4	C37	
Analyse concrete applications of ultrasounds.	B4	C37	D2
Analyse concrete applications of underwater acoustics.	B4	C37	D2
Adaptation of learnt techniques to other applications.	B4		D2

Contents

Topic	
Voice production and perception	Voice generation. Physiology. General characteristics of a speech signal. Perception. Auditive physiology.
Analysis of speech and audio signals	Short term analysis. Time and spectral parameters. Linear Prediction Techniques. Psychoacoustic models.
Speech coding	Waveform coding. Parametric coding. Hybrid coding. Standards. Applications.
Audio Coding	Main characteristics of an audio signal. Time-frequency analysis : filterbanks and transforms. Coding. Standards. Applications.
Underwater acoustics and ultrasounds	Propagation of acoustic waves in water. Applications. Ultrasounds. Applications

Planning

	Class hours	Hours outside the classroom	Total hours
Master Session	21	42	63
Practice in computer rooms	12	9	21
Tutored works	7	57	64
Short answer tests	2	0	2

*The information in the planning table is for guidance only and does not take into account the heterogeneity of the students.

Methodologies

	Description
Master Session	The teacher makes a presentation of some relevant contents of the subject. Some concepts may be illustrated by means of computer simulation. Students are encouraged to make questions and discuss some proposed problems and exercises. The main objective of these sessions is to provide the students with the theoretical background so that they can develop all the subject competences. Therefore, every subject competence is developed in these sessions.
Practice in computer rooms	Students will carry out computer simulations using Matlab, which will help them to better understand the concepts introduced in the theory sessions and to discover new ones. All the subject competences are developed in these sessions.
Tutored works	The students will be grouped into teams which will develop one or several tasks proposed by the teacher. The number of students in a team will be established taking into account the number of students enrolled and the complexity of the proposed tasks. Each team work will be supervised by the teacher who, in addition to evaluate the team work, may establish procedures for self and cross evaluation. Tutored works are thought to develop CG4 and CG6 competences, as well as CE34, CE38 and CT2.

Personalized attention

Methodologies	Description
Practice in computer rooms	The teacher will establish mechanisms to determine the degree of understanding of the main concepts by the students.
Tutored works	At the regular team meetings the teacher will track the work of each student. In addition , the teacher will establish additional mechanisms such as, for instance, cross-evaluation of the student work by his/her team mates.

Assessment

	Description	Qualification	Training and Learning Results		
Tutored works	The evaluation of a team work will be done through the collection of evidences and/or tests during its developement, at personal and group levels, a final report and a presentation and/or test about the work. A final report will be delivered to the teacher around the 14th week of the teaching period. The precise date will be established at the beginning of this period. In order to pass this course a minimum score will be required in the tutored work as explained in the section Other comments and July evaluation.	50	B4 B6	C34 C38	D2
Short answer tests	Final exam with several questions referred to the contents of the subject. In order to pass this course a minimum score will be required in the final exam as explained in the section Other comments and July evaluation.	50	B4 B6	C34 C37 C38	D2

Other comments on the Evaluation

The previously proposed evaluation method will apply to students who follow the recommended continuous evaluation (C.E.) procedure.In order to not handicap his potentia lteam mates,the student will have a brief period to decide whether or not follows the C.E. procedure (as an orientation,the first two weeks of the semester). Students attending only the final exam may obtain the maximum grade in the subject. However, these students will have to answer some additional questions related to the proposed team works in order to demonstrate that they have acquired the same skills that students following C.E.

The July evaluation will consist of a final exam, but students who followed C.E. may choose to keep the grade obtained in the team work instead of answering the additional questions related to these works.

Students will pass the course if they get a final mark equal to or greater than 5 (on a ten-points scale) and a score equal to or greater than 4 (on the same scale) in both the tutored work and the final exam. The individual mark of the tutored work will be obtained as the sum of the mark of the individual tests (30% of the grade of the tutored work) and the mark obtained jointly by the group (70%), although the latter will be weighted according to the results of the cross-evaluations and the teacher's opinion about the student's personal contribution to the group work.

Just in case a student has no grade on the tutored work, or chooses to leave it out at the second call in July, the score obtained in the group of questions related to the tutored work will be considered the grade on the tutored work and the score on the remaining questions will be the final-exam grade. The final mark will be calculated as the sum of the previous scores (tutored work and final exam) achieving 4 points, and dividing this sum by two. In case of not achieving the required 4 points in both parts, the maximum final mark will be 4.5. If both marks are below 4, the final grade will be the lowest of both marks divided by two.

Sources of information
Andreas Spanias, Ted Painter and Venkatraman Attii, **Audio Signal Processing and Coding**, Wiley-Interscience,
Wai C. Chu, **Speech Coding Algorithms: Foundation and Evolution of Standardized Coders**, John Wiley & Sons,
X. Lurton, **An Introduction to Underwater Acoustics. Principles and Applications**, Springer,
Douglas O'Shaughnessy, **Speech Communications. Human and Machine**, Wiley-IEEE Press,
Dutoit, T. and Marqués F., **Applied signal processing : a matlab-based proof of concept**, Springer,
Kuttruff, H., **Acoustics. An introduction**, Taylor & Francis,
D. Ensminger and F. B. Stulen, Eds., **Ultrasonics. Data, Equations, and Their Practical Uses**, CRC Press,
Boss, M. and Goldberg, R. E., **Introduction to digital audio coding and standards**, Kluwer Academic Publishers,

Recommendations

Subjects that it is recommended to have taken before
Fundamentals of Sound and Image/V05G300V01405
Digital Signal Processing/V05G300V01304

Other comments
It is assumed that the student has some basic skills in Matlab.