



IDENTIFYING DATA

Fundamentals of Sound and Image

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|---------------------|---|-----------|------|------------|
| Subject | Fundamentals of Sound and Image | | | |
| Code | V05G306V01209 | | | |
| Study programme | Grado en Ingeniería de Tecnologías de Telecomunicación | | | |
| Descriptors | ECTS Credits | Choose | Year | Quadmester |
| | 6 | Mandatory | 2nd | 2nd |
| Teaching language | English | | | |
| Department | | | | |
| Coordinator | Rodríguez Vaqueiro, Yolanda | | | |
| Lecturers | Rodríguez Vaqueiro, Yolanda | | | |
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| Web | http://https://moovi.uvigo.gal | | | |
| General description | "Sound & image fundamentals" presents some basic concepts on sound & image nature, the course also deals with some basic processing of these signals. | | | |

Training and Learning Results

| | | | |
|------|--|--|--|
| Code | | | |
| B3 | CG3: The knowledge of basic subjects and technologies that enables the student to learn new methods and technologies, as well as to give him great versatility to confront and adapt to new situations | | |
| B5 | CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area. | | |
| C13 | CE13/T8: The ability to understand the electromagnetic and acoustic wave mechanisms of propagation and transmission, and their corresponding receiving and transmitting devices. | | |
| C48 | (CE48/T16) The knowledge of the appropriate techniques to develop and exploit signal processing subsystems. | | |
| C49 | (CE49/T17) The ability to analyze digital signal processing schemes. | | |
| D3 | CT3 Awareness of the need for long-life training and continuous quality improvement, showing a flexible, open and ethical attitude toward different opinions and situations, particularly on non-discrimination based on sex, race or religion, as well as respect for fundamental rights, accessibility, etc. | | |

Expected results from this subject

| Expected results from this subject | Training and Learning Results | | |
|---|-------------------------------|------------|----|
| Acquire mathematical tools that allow the understanding of the practical effects of sampling, windowing and time-frequency analysis of sound and image signals. | B3 | C48 C49 | D3 |
| Apply quantification techniques | B3 | C48 C49 | D3 |
| Understand the nature, basic properties, generation and capture of sound and image. | | C13 | D3 |
| Understand and interpret the different levels of measurement present in sound systems. | B5 | | D3 |
| Review the different processes and systems associated with the treatment of sound and image | B3 B5 | C48 C49 | D3 |
| Apply the basic rules of the colorimetry. | B3 | | D3 |

Contents

| | | | |
|--|---|--|--|
| Topic | | | |
| Sampling, windowing and quantification of one-dimensional and two-dimensional signals. | <ul style="list-style-type: none"> - Sampling, Nyquist theorem, reconstruction filter. - 2D sampling, concept of resolution vs. sampling frequency. 2D reconstruction. - Windowing in 1D and 2D. - Uniform quantization. A/D conversion . Quantization noise. | | |

| | |
|---|--|
| Time-frequency analysis of sound and image signals. | <ul style="list-style-type: none"> - Sound and image characteristics in time and double spatial dimension, respectively. - Windowing and Discrete Fourier Transform (DFT). DFT in 2D. - Frequency characteristics. Spatial frequencies, physical interpretation. |
| Basic concepts of light and color. | <ul style="list-style-type: none"> - The image: numerical nature, colorimetry, visual system basics. |
| Acoustics: basics. Measurement of acoustic signals. | <ul style="list-style-type: none"> - The sound: acoustic variables, generation, combination of sources, sound sensations - Measurement levels. - Sound level meter |
| Sound and image systems and processes: basics. | <ul style="list-style-type: none"> Filter banks. - Sound capture and calibration. - Specifications and objective quality. - 1D filtering. FIR and IIR filters. Relation between windowing and filtering. - 2D filtering. Separable filters. Point operations and spatial filtering on images. |
| Practices | <p>Audio</p> <ul style="list-style-type: none"> -Localized analysis of audio signals -Spectrogram -Calculation of sound pressure levels -Calibration of sound pressure levels <p>Image</p> <ul style="list-style-type: none"> -Image processing in Matlab -Filtering and restoration of images |

Planning

| | Class hours | Hours outside the classroom | Total hours |
|---------------------------------|-------------|-----------------------------|-------------|
| Introductory activities | 1 | 0 | 1 |
| Lecturing | 31 | 39 | 70 |
| Problem solving | 8 | 12 | 20 |
| Practices through ICT | 19 | 18 | 37 |
| Discussion Forum | 0 | 1 | 1 |
| Objective questions exam | 4 | 2 | 6 |
| Problem and/or exercise solving | 0 | 2 | 2 |
| Problem and/or exercise solving | 0 | 2 | 2 |
| Essay | 0 | 11 | 11 |

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

Methodologies

| | Description |
|-------------------------|--|
| Introductory activities | <p>Course presentation: programme, reading materials, teaching methodology and assessment system.</p> <p>Developed capabilities: B3, B5, C13, D3, C48, C49.</p> |
| Lecturing | <p>Exposition by the teacher of the main concepts of each topic, promoting critical discussion. The theoretical foundations of algorithms and procedures used to solve problems are laid. The student should take as reference the content of the exam indicated in the guide document for each topic.</p> <p>Subsequent personal work of the student reviewing the concepts seen in the classroom and expanding the contents taking as reference the notes documents of each topic.</p> <p>Identification of doubts that need to be resolved in personalized tutorials.</p> <p>Developed capabilities: B3, B5, C13, D3, , C48, C49.</p> |
| Problem solving | <p>Problems and exercises formulated according to the content of the lectures and the documents for each subject.</p> <p>Students solve problems and exercises prior to the class.</p> <p>Identification of doubts that need to be resolved in personalized tutorials.</p> <p>Developed capabilities: B3, B5, C13, D3, , C48, C49.</p> |

Practices through ICT Handling of analysis tools and algorithms. Identifying which one must to be used to solve each specific problem.

Identification of doubts that need to be resolved in personalized tutorials.

Developed capabilities: B3, B5, C13, D3, , C48, C49.

Discussion Forum The website for the course is included in the platform (<https://moovi.uvigo.gal>). Subscription to this platform, including a photograph, is mandatory. The website provides all the information related to the course. It also publishes continuous assessment grades and runs forums for students to exchange ideas and discuss doubts.

Developed capabilities: B3, B5, C13, D3, C48, C49.

Personalized assistance

| Methodologies | Description |
|-----------------------|---|
| Problem solving | Help with problem solving, in the classroom and/or at the office. https://moovi.uvigo.gal/user/profile.php?id=11310 https://moovi.uvigo.gal/user/profile.php?id=11639 |
| Practices through ICT | Help in the classroom and, if necessary at the office or via e-mail. https://moovi.uvigo.gal/user/profile.php?id=11310 https://moovi.uvigo.gal/user/profile.php?id=11639 https://moovi.uvigo.gal/user/profile.php?id=35677 |
| Lecturing | Query and answer in the classroom and, if necessary, at the office. https://moovi.uvigo.gal/user/profile.php?id=11310 https://moovi.uvigo.gal/user/profile.php?id=11639 |

Assessment

| | Description | Qualification | Training and Learning Results | |
|---------------------------------|--|---------------|-------------------------------|-------------------|
| Objective questions exam | Made in the platform Moovi or by written tests in the classroom. | 20 | B3 | C48 C49 |
| Problem and/or exercise solving | Exam with brief questions and problems on the thematic of sound | 25 | B3 | C48 C49 |
| Problem and/or exercise solving | Exam with brief questions and problems on the thematic of image | 25 | B3 | C48 C49 |
| Essay | Supervised work related with the contents of the practices | 30 | B3 B5 | C13 C48 C49 |

Other comments on the Evaluation

On detecting any kind of plagiarism in any of the tests (short test, partial or final exam, lab reports) the final qualification will be FAIL (0) and the fact will be transmitted to school regents for taking the appropriate actions.

There are two kinds of assesment: continuous assesment and global assesment.

The schedule for intermediate evaluation tests will be approved by the CAG (DEGREE ACADEMIC COMMITTEE) and will be published at the beginning of four month period in which this course is delivered.

CONTINUOUS ASSESSMENT

The continuous assessment consists of the tests detailed below in this guide and are not recoverable, that is, if a student cannot take them on the stipulated date, the teacher is not required to repeat them. The evaluable tasks will be valid only for the academic year in which they are carried out. The submission of assignments is not mandatory. Assignments not submitted will be evaluated with zero points

It is understood that the student opts for continuous evaluation once the commitment document that will be offered after the first month si signed, so that work can begin in the corresponding groups. Once signed, the student will be assigned the grade that results from the application of the criteria detailed below, regardless of whether or not they take the final exam.

Types and evaluation of tests:

1. Delivery of two supervised group projects related to the practices (weight 30%). The individual grade of the group work will be determined by means of cross evaluation and personal interview.
2. Resolution of tests or short questions related to the practical contents (Weight: 20%): they are developed throughout the course on the Moovi platform.
3. Test 1: final written test of the sound part (development, Weight: 25%): it takes place approximately halfway through the semester.
4. Test 2: final written test of the image part (development, Weight: 25%): coincides with the date of the final exam of the subject.

In order to guarantee that students acquire a minimum, more or less balanced, of the subject competences, to pass they will need to meet these conditions:
 Obtain a minimum of 3.5 in Test 1. Obtain a minimum of 3.5 in Test 2. Get an average of more than 5 in Tests 1 and 2. Obtain an average of more than 5 in supervised group projects.
 In case of not fulfilling all the conditions, the final grade (on a scale of 0 to 10) will be the minimum between the overall grade obtained and the value FOUR.
 To participate in the Continuous Assessment, 80% attendance is required for groups A and B. In case of non-compliance, the student will be assessed in the single assessment option.
 Any student can be called at any time by the teachers to carry out a review of the work done to date in the works or projects in progress.

GLOBAL ASSESSMENT

If the student does not sign the commitment document, he/she will be evaluated by means of an only exam, in the official date. The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course, including the laboratory works.

In order to ensure that students acquire a balanced minimum on the subject competences, they will pass the course if they meet these two conditions:

- 1) get a final mark equal to or greater than 5 (on a ten-points scale)
- 2) and a score equal to or greater than 4 in the questions related with the group B and supervised group projects activities.

If some of these conditions are not fulfilled, then the final grade (on a ten-points scale) will be the minimum between the final mark and the value "4.9".

Extraordinary exam:

⇒ **Students evaluated by Continuous Assessment in the ordinary opportunity can opt between two possibilities the same day of the exam:**

- 1. Do again Test 1 and 2 and be evaluated according what is stipulated for the system of Continuous Assessment.
- 2. Be evaluated with a single final exam in the official date assigned by the Centre. The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course. Non Continuous Assessment rules apply.

⇒ **Students not evaluated by Continuous Assessment:**

They will be evaluated with a single final exam on the official date assigned by the Center. The grades for this final exam are between 0 and 10 points. It includes all the subjects of the course. Non Continuous Assessment rules apply. No other activities are assessed.

End of program Exam:

In special call exam (end of degree), we will proceed as in the case of students who have not completed the continuous assesment.

Sources of information

Basic Bibliography

Finn Jacobsen et al., **FUNDAMENTALS OF ACOUSTICS AND NOISE CONTROL**, Technical University of Denmark, 2001
 Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, **Digital image processing using MATLAB**, Gatesmark Publishing, 2009

Günther Wyszecki, W.S. Stiles, **Color science: concepts and methods, quantitative data, and formulae**, John Wiley & Sons,

Complementary Bibliography

Lawrence Kinsler, Austin Frey, Alán Coppins, James Sanders, **FUNDAMENTALS OF ACOUSTICS**, John Wiley & Sons, 1999

Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab, **Signals and systems**, Prentice-Hall, 1997

Alan V. Oppenheim, Ronald W. Schaffer., **Discrete-time signal processing**, Pearson Prentice Hall, 2010

Rafael C. Gonzalez, Richard E. Woods, **Digital image processing**, Pearson Prentice Hall, 2018

R.J. Clarke, **Digital compression of still images and video**, Academic Press, 1995

Recommendations

Subjects that continue the syllabus

Room Acoustics/V05G301V01330

Design of audiovisual installations/V05G301V01334
Fundamentals of Acoustics Engineering/V05G301V01327
Fundamentals of Image Processing/V05G301V01333
Sound Processing/V05G301V01328
Interactive Audio Systems/V05G301V01331
Imaging Systems/V05G301V01332
Video and Television/V05G301V01329

Subjects that it is recommended to have taken before

Physics: Fundamentals of Mechanics and Thermodynamics/V05G301V01103
Digital Signal Processing/V05G301V01205

Other comments

The use of generative artificial intelligence (GAI) is allowed while carrying out the academic activities of this subject. Its use must be ethical, critical and responsible. When using GAI, any result should be critically evaluated, and any citations or references generated should be carefully verified. Likewise, it is recommended to declare the use of the tools used.
