2010-11 academic year

Architectural Acoustics (21609)

Degree/study: Bachelor's degree in Audiovisual Systems Engineering
Year: 2nd
Term: 3rd
Number of ECTS credits: 4 credits
Hours of studi dedication: 100 hours
Teaching language or languages: language
Teaching Staff: Jordi Arqués

1. Presentation of the subject

This subject provides the students with the basic principles on sound behaviour in rooms and the subjective effects that listeners may perceive.

Aspects such as the interaction between sound and different materials will be explained which will lead to the introduction of the concepts of absorption and diffusion. Some techniques to predict and measure the sound field and the parameters that define the acoustic quality of a room or space will also be introduced.

In the practice sessions, students will become acquainted with the different measuring tools and will use standard measuring techniques in different situations. They will have to take into account different aspects regarding acoustic and design criteria for different spaces: conference rooms, theatres, etc.

2. Prerequisites to follow the subject

Students are expected to have some knowledge on the topics covered in the Acoustics Engineering subject; that is the physical and mathematical fundamentals of wave acoustics and psychoacoustics. They also need to have some basic knowledge on mathematical analysis and be familiar with the use of computers.

It is therefore necessary to have taken the following subjects: Numeric Calculation and Methods, Linear Algebra and Discrete Mathematics, Waves and Electromagnetism and Acoustic Engineering.

3. Competences to be acquired in the subject

General Competences	Specific Competences
Instrumental 1. Capacity to link different ideas 2. Capacity to analyse and summarize 3. Logical reasoning 4. Time management and planning Interpersonal 1. Capacity to work in groups to solve problems. 2. Capacity to explain ideas and	1. Knowing the fundamentals of sound propagation in different places 2. Knowledge on the behaviour of the different acoustic materials 3. Being able to identify the acoustic problems that arise in different places 4. Being able to solve the problems that arise in different places 5. Capacity to use the basic measuring tools.

solutions precisely, both orally and in written. Systhemic 1. Capacity to put the theory knowledge into practice 2. Capacity to look for the best solution according to the context. 3. Capacity to use the knowledge acquired in the subject to solve new problems.	6. Capacity to analyse and interpret the acoustic measuring relating objective data and the subjective perception characteristics. 7. Capacity to predict the characteristics and potential problems of an environment before performing a measurement.

4. Contents

4.1. Theoretical part:

Block I Fundamentals of Acoustics and Psychoacoustics
1.1 Sound definition, generation and propagation
1.2 Sound classification
1.3 Equal-loudness contour. Sound levels according to frequency.
1.4 Sound measurement. Sound level meters
1.5 Background noise levels. NC curves ("Noise Criteria") and NR.
1.6 Sound intensity levels and sound power
1.7 Kinds of sound sources
1.8 Sound superposition and the "comb filter" effect.
1.9 Influence of limit surfaces
1.10 Sonority
1.11 The human phonation mechanism
1.12 Characteristics of the oral message
1.13 Directivity in the human voice and in musical instruments. Sonograms.

Block II: Sound in different places.
2.1 Geometric acoustics. First considerations. Reflectors. Focalizations, echo and flutter echo
2.2. Wave acoustics. Specific modules
2.3. Statistic acoustics. Reverberation time. Direct field and reverberant field. Determination of the total level of sound pressure in an enclosed space.
2.4 Sound absorption. Topologies of absorbing materials. Acoustic resonators.
2.5 Sound diffusion. MLS and QRD diffusers.
2.6 Variable acoustics systems
2.7 Intelligibility of a word: %ALCONS and STI/RASTI
2.8 Other parameters to be taken into account to measure a room's quality: clarity, definition, acoustic warmth, brightness, EDT

Block III: Acoustic insulation
3.1 Airborne noise and structural noise
3.2 Definition of the basic acoustic insulation indices. The law of mass action. The coincidence effect.
3.3 Indirect ways of noise ("flanking")
3.4 Impact noise. Laminate flooring. Insulating false ceilings
3.5 Integral solutions for acoustic insulation

Bloc IV: Acoustic design of communal use areas, conference rooms, teaching rooms
4.1 Acoustic objectives
4.2 Echoes and focalizations
4.3 Drum effect
4.4 PA systems

Bloc V: Acoustic design of theatres and concert venues.
5.1 Types of theatres

5.2 Acoustic objectives
5.3 Types of concert venues
5.4 Acoustic objectives

Bloc VI: Introduction to the use of acoustic design of spaces software
6.1 Room simulation
6.2 Calculating the transfer function
6.3 Auralization

4.2. Seminars:

Bloc I: Using the sound level meter and sound pressure measurements
1.1 Working principles, related physical magnitudes
1.2 Integration time, weighting, L_{eq}, statistics; octave and third bands;
1.3 Calibration, use as a sound level meter and spectrum analyser
1.4 NC curves.

Bloc II: Measuring impulse responses
2.1 IR measurement theory with several methods
2.2 "Sine sweep" method and its advantages

Bloc III: Using Adobe Audition with a sound card
3.1 Introduction to sound signal recording and reproduction
3.2 A/D D/A conversion and data storage
3.3 Sampling frequency and frequency response
3.4 Bit depth and dynamics in acquisition and procession
3.5 Using Audition, managing and editing audio files
3.6 Using the Aurora plug-in for sweep generation and computation of impulse responses.

Bloc IV: Ambisonic technology and Soundfield microphone
4.1 Ambisonic fundamentals
4.2 Microphones and capsules for Ambisonic
4.3 Using Ambisonic to perform acoustic measurements: velocity, intensity, energy
4.4 Measuring impulse responses for convolution and spatialization

4.3. Practice exercises:

Measuring two rooms with a dodecahedral loudspeaker, a sound level meter and an acquisition system.
Data analysis and result interpretation.

5. Assessment

The three activities that constitute the course (that is, lectures, labs and seminar sessions) are assessed separately. These three assessments constitute the global assessment for the whole subject. It is calculated as follows:

T: Assessment for the theory component through a final written exam
L: Assessment for the lab sessions through some practical exercises to be handed in
S: Assessment for the seminar sessions through a written exam that also assesses the theory component

The final grade corresponds to the mean, which is calculated as follows:

Final grade= 0,5T+0,3L+0,2S

There will be a final exam at the end of the course, which will assess all the competences in which students will have worked on throughout the course. This assessment is compulsory and constitutes the evaluation for the subject's theory and seminar components.

6. Bibliography and teaching resources

6.1 Basic Bibliography

CARRIÓN, A. "Diseño acústico de espacios arquitectónicos", Ediciones UPC, 2nd edition, 2006. ISBN 8483012529
KUTRUFF, H. "Room Acoustics" fifth edition, Spon Press 2009, ISBN 0-203-87637-7
ALTON EVEREST, F., "Master Handbook of Acoustics", McGraw-Hill. Fourth Edition, ISBN: 0 07 136097 2

6.2 Further Readings

BALLOU, G. "Handbook for Sound Engineers", Focal Press, 3rd edition, 2002. ISBN 0 240 80454 6
BERANEK, L. "Concert Halls and Opera Houses". Springer-Verlag New York, Inc. Second Edition ISBN: 0 387 95524 0
DAVIS, D. & PATRONIS, E. "Sound System Engineering". Focal Press. Third Edition ISBN 13: 978 0 240 80830 7
LONG, M. "Architectural Acoustics", Elsevier Academic Press, 2006. ISBN 0 12 455551 9
KINSLER, L. "Fundamentos de acústica", Ed. Limusa, 1st edition, 1988. ISBN 978 9 68 182026 8
BARRON, M. "Auditorium acoustics and architectural design", E & FN Spon, 1993. ISBN 0 419 17710 8
RECUERO, M. "Acústica Arquitectónica Aplicada", Paraninfo, 1999.ISBN 978 8 42 832571 4

6.3 Didactic Resources

The didactic ressourses for the subject can be found in the Aula Global. There are also resources and links to articles on specific subjects dealt in subject which are available in the Aula Global.

7. Metodology

The usual learning process starts with a lecture where some theory and practice Fundamentals are presented. Students are expected to complement this activity by carefully reading their notes and the additional material supplied.

Seminars and laboratory sessions will be devoted to a previous explanation on the characteristics and theory aspects regarding tools and programmes, their use and measuring in different contexts.