Universitat d'Alacant
Universidad de Alicante

20020 - INSULATION AND SOUNDPROOFING (2018-19)

General

Code: 20020
Lecturer responsible:
CALZADO ESTEPA, EVA MARIA

Credits ECTS:	**6**
Theoretical credits:	1,2
Practical credits:	1,2
Distance-base hours:	3,6

Departments involved

- **Dept:** PHYSICS, ENGINEERING SYSTEMS AND SIGNAL THEORY
  Area: APPLIED PHYSICS
  Theoretical credits: 1,2
  Practical credits: 1,2
  This Dept. is responsible for the course.
  This Dept. is responsible for the final mark record.

Study programmes where this course is taught

- DEGREE IN SOUND AND IMAGE IN TELECOMMUNICATION ENGINEERING
  Course type: COMPULSORY (Year: 3)

Competencies and objectives

Course context for academic year 2018-19

It is recommended to take this course after passing the following exams:

-Acoustics
-Acoustic Transducers

Subject is taught in the first four months of the third year, after Acoustics, Fundamentals of Engineering Optics (first four months of second year) and Acoustic Transducers (last four months of second year).
Insulation and soundproofing is conceptually supported by the concepts taught in the second year subjects. On the other hand, the fundamentals of the subject will be supplemented and deepened in Vibroacoustics and Acoustic Design of Venues, subjects that are conceived as an extension of this subject.

Course content (verified by ANECA in official undergraduate and Master's degrees)

UA Basic Transversal Competences

- **CT10 :** Capacity to confront, plan and solve real problems demanded by society in the field of engineering.
- **CT11 :** Capacity to learn and apply new concepts and methods in an autonomous and interdisciplinary fashion.
- **CT12 :** Capacity to assimilate and adapt to the permanent evolution of technology when developing one's professional career.
- **CT13 :** Capacity to adopt the scientific method when planning and carrying out different academic and professional tasks.
- **CT14 :** Capacity for self-criticism needed to analyse and improve the quality of projects.
- **CT6 :** Capacity to use the English language fluently to access technical information, respond to the needs of society and be self-sufficient when preparing one's professional career.
- **CT7 :** Capacity for oral and written exposition.
- **CT8 :** Capacity to plan tasks and commit oneself to satisfying goals and deadlines.
- **CT9 :** Capacity for group work.

Specific Competences:>>Basic

- **B3 :** Understand and master the basic concepts of the general laws of mechanics, thermodynamics, fields and waves and electromagnetism the their application to solve engineering problems.

Basic Transversal Competences

- **CT2 :** Students should know how to apply their knowledge to their job or vocation in a professional manner and should possess those skills that are usually reflected when preparing and defending arguments and solving problems in their field of study.
- **CT3 :** Students should have the ability to gather and interpret relevant data (normally within their field of study) to give opinions that include a reflection on important, social, scientific, ethical matters, etc.
- **CT4 :** Students should be able to transmit information, ideas, problems and solutions to both specialist and non-specialist audiences.
- **CT5 :** Students should have developed the necessary learning skills to take on later studies with a high level of autonomy.

Specific Competences: >> Competences Common to the Telecommunications Branch

- **C3 :** Capacity to use computer tools to find bibliographic resources and information related to telecommunications and electronics.
- **C8 :** Capacity to understand the mechanisms for propagating and transmitting electromagnetic and acoustic waves, and their corresponding transmitting and receiving devices.

Specific Competences: >> Competences Specific to Sound and Image

- **E3 :** Capacity to carry out projects for premises and facilities intended for producing and recording audio and video signals.
- **E4 :** Capacity to carry out acoustic engineering projects on: Insulation and acoustic preparation of premises, Public address installations, Specification, analysis and selection of electroacoustic transducers, Systems for the measurement, analysis and control of noise and vibration, Environmental acoustics, Underwater acoustic systems.

Exclusive skill taught in this course

No data

Learning outcomes (Training objectives)

No data

Specific objectives stated by the academic staff for academic year 2018-19

Apply the fundamentals of the statistical, geometric and wave theories to room acoustics.
Apply the concept of reverberation time.
Apply regulations and standards to experimentally obtain the reverberation time.
Know the phenomenology of absorption in order to control reverberation and the techniques in order to obtain the absorption coefficient of a material.
Know the most important quality parameters in room acoustics.
Know the parameters that characterize sound insulation between enclosures and the most used parameters as quality and nuisance indices.
Learn basic sound insulation prediction models between enclosures.
Know and understand current regulations in order to determine airborne and impact sound insulation between enclosures.

Content and bibliography

Content for academic year 2018-19

INSULATION AND SOUNDPROOFING
BLOCK I: INTRODUCTION
UNIT 1: FUNDAMENTALS OF ACOUSTICS APPLIED TO INSULATION AND SOUNDPROOFING
1.1 Introduction
1.2 Sound Power, Intensity and Pressure
1.3 Spherical Waves
1.4 Directivity Factor: Q
1.5 Sound Pressure Levels and Decibels
1.6 Superposition of Sound Pressure Levels
1.7 Characterization of Sound
1.8 Noise Description
1.8.1 Spectral Analysis
1.8.2 Time Analysis. Types of Noise
1.8.3 Noise Assessment
1.9 Measuring Devices

BLOCK II: SOUNDPROOFING
UNIT 2: SOUND FIELD IN AN ENCLOSED SPACE
2.1 Introduction
2.2 Properties of Sound Propagation
2.3 Statistical Theory
2.3.1 Introduction to Statistical Theory
2.3.2 Reverberation Time. Sabine Equation
2.3.3 High Sound Absorbing Spaces. Eyring Equation
2.3.4 Millington Equation
2.3.5 Direct and Reverberant Field: Critical Distance
2.4 Geometric Theory
2.4.1 Reflection of Sound
2.4.2 Production and Perception of Echoes
2.4.3 Sound Rays Focusing and Dispersion
2.4.4 Acoustic Shadows
2.5 Wave Theory
2.5.1 Vibrational Normal Modes (Vibration Eigenmodes)
2.5.2 Resonance Phenomena
2.5.3 Getting the Natural Frequencies for a Rectangular Room with Rigid Walls

UNIT 3: ACOUSTIC PROPERTIES OF MATERIALS
3.1 Introduction
3.2 Sound Absorbing Materials
3.2.1 Noise Reduction Coefficient
3.2.2 Mounting Conditions Effects on Sound Absorption Coefficients
3.3 Acoustic Resonators
3.3.1 Acoustic Diaphragm or Membrane

3.3.2 Single Cavity Resonator (Helmholtz)
3.3.3 Multiple Cavity Resonator (Helmholtz) Based on Perforated or Slotted Panels
3.4 Acoustic Reflectors
3.5 Acoustic Diffusers
3.5.1 Schroeder Diffusers
3.5.2 Other Diffusers
3.6 Bass Traps
3.7 Movable Acoustic Walls

TEMA 4: ROOM ACOUSTICS
4.1 Introduction
4.2 Brief Historical Description of Room Acoustics
4.3 Acoustic Factors in Architectural Design
4.4 Criteria and Parameters in Room Acoustics
4.5 Soundproofing and the TBC (Technical Building Code)

BLOCK III: SOUND INSULATION
UNIT 5: ACOUSTIC TRANSMISSION IN BUILDING DESIGN
5.1 Introduction to Sound Insulation
5.2 Noise Sources in Buildings
5.3 General Approach
5.3.1 Airborne Noise Transmission
5.3.2 Vibration and Impact Noise Transmission
5.4 Sound Transmission Loss Through Walls
5.4.1 Sound Transmission Loss Through Single Layer Walls
-Mass Law
-Coincidence Frequency
5.4.2 Sound Transmission Loss Through Multiple Layer Walls
- Double Layer Resonance
- Air Chamber Resonance // Standing Waves
- Coincidence Effect
- Acoustic Bridges

5.5 Enclosure Openings
5.5.1 Windows
5.5.2 Doors
5.6 Sound Insulation of Composite Construction Elements
5.7 Horizontal Construction Elements
5.8 Comparison Between Airborne and Impact Noise

UNIT 6: MEASUREMENTS AND EVALUATION OF SOUND INSULATION IN BUILDINGS
6.1 Nuisance Levels
6.2 ISO Standards
6.3 Airborne Sound Insulation According to ISO Standards
6.3.1 Indices for Assessing Airborne Sound Insulation
6.3.2 Evaluation and Testing Procedures
6.3.3 Single Number Quantity Characterization of Airborne Sound Insulation
6.3.4 Contents of Test Report for Airborne Sound Insulation
6.4 Impact Sound Insulation According to ISO Standards
6.4.1 Indices for Assessing Impact Sound Insulation

6.4.2 Evaluation and Testing Procedures
6.4.3 Single Number Quantity Characterization of Impact Sound Insulation
6.5 Noise Assessment Criteria

UNIT 7: NOISE CONTROL FOR BUILDINGS

7.1 Indirect Sound Transmission Routes
7.2 Flanking Sound Transmission
7.3 Effects of Cracks and Holes on Sound Insulation
7.4 Acoustic Bridges
7.5 Air Conditioning Systems
7.6 Sound Transmission Through Facilities
7.6.1 Plumbing
7.6.2 Elevators and Freight Lifts
7.6.3 Heating Systems
7.7 Attenuation Methods for Impact Noise and Vibrations
7.8 Introduction to Vibration Control
7.9 Noise Barriers (Soundwalls)

UNIT 8: BUILDING PROTECTION AGAINST NOISE: TBC (TECHNICAL BUILDING CODE)
8.1 Introduction.
8.2 Sound Insulation Indices.
8.3 Sound Transmission Routes
8.4 Characterization and quantification of the requirements:
8.4.1 Limit Values for Sound Insulation
8.4.2 Limit Values for Reverberation Times
8.4.3 Facilities Noise and Vibrations
8.5 TBC Sound Insulation Calculation (BD-HR)

LABORATORY EXPERIENCES

BLOCK II:
1. MEASURING THE REVERBERATION TIME OF A ROOM
2. MEASURING THE SOUND ABSORPTION COEFFICIENT IN A REVERBERATION CHAMBER
3. DETERMINING ECHOES AND FIRST SOUND REFLECTIONS OF A ROOM

BLOCK III:
4. MEASURING AIRBORNE AND IMPACT SOUND INSULATION ACCORDING TO ISO STANDARDS PART I
5. MEASURING AIRBORNE AND IMPACT SOUND INSULATION ACCORDING TO ISO STANDARDS PART II
6. CALCULATING SOUND INSULATION IN DWELLINGS (GENERAL METHOD)

Basic transversal and specific competences are developed along the entire syllabus of the subject.

Assessment

Assessment procedures and criteria 2018-19

Attendance and carrying out of laboratory practices is mandatory. The exams will be done in English.

If the students fail to pass continuous evaluation, they must take a final exam in order to recover the theoretical and exercise solving parts of the course. This exam will account for the 80% of the final mark of the course. Laboratory reports may be delivered again if the students have failed to pass continuous evaluation and need to upgrade the marks obtained.

It is not possible to carry out again laboratory practices for July and December calls. There will be an exam in order to recover the theoretical and exercise solving parts of the course. This exam will account for the 80% of the final mark of the course. Laboratory practices mark (related to the laboratory practices reports) may be upgraded delivering again the corrected laboratory reports (20%), provided that students have attended the laboratory sessions.

The theoretical/practical works must be original. Copying or plagiarism detection will result in a “0” mark in the corresponding test. This
incidence will be reported to the Department and the Higher Polytechnic School management. The repeated misconduct in this or any other subject will be reported to the vice-rectorate in order to study the case and punish it pursuant to the law (Regulations on academic discipline of Higher and Technical Education Institutions under the Ministry of National Education, BOE 10/12/1957).

Description	Criteria	Type	Weighting system
THEORETICAL + EXERCISE LECTURES	TWO TESTS + EXERCISES during THEORETICAL/EXERCISE LECTURES corresponding to the blocks II (SOUNDPROOFING) and III (SOUND INSULATION) . Continuous evaluation tests+exercises will be held once each block are finished. 7th WEEK.....SOUNDPROOFING 14th WEEK.....SOUND INSULATION	ACTIVITIES OF EVALUATION DURING THE SEMESTER	30
LABORATORY EXPERIENCES	Lab reports submission for the 6 experiences. Submission should take place at the beginning of the following laboratory session.	ACTIVITIES OF EVALUATION DURING THE SEMESTER	20

FINAL EXAMINATION	Concepts related to theoretical lectures, exercise lectures and laboratory experiences will be evaluated. In the July extraordinary exam, it is not possible to resit the laboratory experiences so there will be an special exam so as to resit every part of the subject.	FINAL TEST	50

Official exam dates for academic year 2018-19

Exam session	Date	Time	Group - Classroom(s) allocated	Comments
(C2) Periodo ordinario para asignaturas de primer semestre	23/01/2019	15:00 - 18:00	EP/S-02M	Teoría
(C4) Pruebas extraordinarias para asignaturas de grado y máster	03/07/2019			Teoría