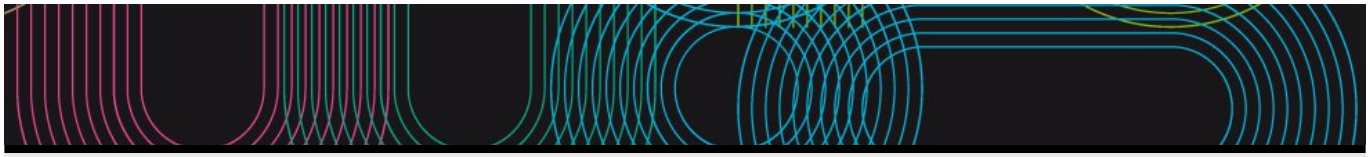

IDENTIFYING DATA				
Advanced acoustics				
Subject	Advanced acoustics			
Code	V05G300V01933			
Study programme	Degree in Telecommunications Technologies Engineering			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	Spanish English			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	García Lomba, Guillermo Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://faitic.uvigo.es			
General description	In this subject, the use of advanced calculation methods in Acoustics are introduced. The Finite Element Method (FEM) and the Boundary Element Method (BEM) are applied to study problems of acoustic radiation, diffraction and modal analysis (calculation of mode shapes and resonance frequencies). Statistical Analysis Methods (SEA) are also introduced and applied to the calculation of flanking transmission in buildings. The language of the subject is mostly English, although the first lessons on Finite Element Methods could be explained in Spanish.			

Competencies

Code	
B2	CG2: The knowledge, comprehension and ability to apply the needed legislation during the development of the Technical Telecommunication Engineer profession and aptitude to manage compulsory specifications, procedures and laws.
B5	CG5: The knowledge to perform measurements, calculations, assessments, appraisals, technical evaluations, studies, reports, task scheduling and similar work to each specific telecommunication area.
B7	CG7: The ability to analyze and assess the social and environmental impact of technical solutions.
C75	(CE75/OP18) The ability to elaborate noise maps and their geographical information display.
C76	(CE76/OP19) The ability to apply numerical methods in acoustical problem solving.
C77	(CE77/OP20) The ability to indentify industrial noise problems and to design appropriate control solutions.

Learning outcomes

Expected results from this subject	Training and Learning Results	
Knowledge on the application of numerical methods in acoustics.	B2	C75
Knowledge on the application of calculation models of sound transmission in structures.	B5	C76
Knowledge on design techniques of mufflers.	B7	C77
Capacity for understanding the results of complex acoustic measures and relate them with the calculations obtained by means of simulations.		
Knowledge of noise control measures in industrial environments.		

Contents

Topic	
Introduction.	Review of acoustic concepts: impedance, boundary conditions, Helmholtz and Euler equations.

The Finite Elements Method in Acoustics (FEM)	Theoretical introduction to the Finite Element Method. Radiation Problems with FEM. Diffraction Problems. Modal analysis with FEM: resonance frequencies and modes
The Boundary Element Method in Acoustics (BEM)	Introduction to the Boundary Element Method in Acoustics. Integral equation of Kirchhoff Helmholtz. Application to radiation and diffraction problems. The calculation of resonances in BEM.
Calculation methods based in S.E.A. Calculation of sound transmission in buildings.	Building Acoustics: acoustic insulation in buildings and determination of the flanking transmission. Calculation method of the international standard ISO 12354.
Other calculation methods.	Ray tracing and application to evaluation of sound propagation outdoors. Prediction of noise levels in industrial plants. Noise control.

Planning

	Class hours	Hours outside the classroom	Total hours
Tutored works	6	24	30
Practice in computer rooms	12	9	21
Previous studies / activities	0	15	15
Master Session	19	38	57
Short answer tests	2	8	10
Jobs and projects	2	10	12
Reports / memories of practice	1	4	5

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

Methodologies

	Description
Tutored works	Practical projects that the students have to develop: 1. Design of a diffuser to optimise the radiation pattern of a loudspeaker. 2. Design and calculation of the acoustic insulation of a building. Through this methodology the general competencies CG2, CG5, CG7 and the specific competency CE77 are developed. Transversal competencies as CT3 and CT4 are also developed.
Practice in computer rooms	The student will work with different software packages to apply the different calculation methods presented un the subject. 1. CAD and mesh generation: FreeCAD and Gmsh. 2. Finite Element calculations : COMSOL. 3. Boundary Element calculations: OpenBEM. 4. Calculations in building acoustics. Through this methodology the specific competencies CE 75, CE67 and CE77 are developed
Previous studies / activities	The students must study and prepare with the sources of information given before the lectures and the practical sessions. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.
Master Session	Lectures will be given, developing the main theoretical concepts of the subject. Through this methodology the general competencies CG2, CG5, CG7 and the specific competencies CE75, CE76 and CE77 are developed.

Personalized attention

Methodologies	Description
Master Session	Lectures are develop within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions.
Tutored works	Tutored works are developed in small working groups. The works are followed during meetings between the groups and the teacher. In those meetings the students can interact and ask their questions to the teacher.
Practice in computer rooms	In practical sessions, each student must solve his/her own tasks. The teacher will be available during the session to solve any problem/question or doubt the student may have.

Assessment

Description	Qualification	Training and Learning Results

Tutored works	Tutored practical project, with the delivery of a final report. The learning aims related to the ability to elaborate projects and application of calculation methods (numerical methods) are assesed. Learning aims related to the identification of problems are also assessed (through the application of numerical calculations).	25	B2 B5 B7	C75 C77
Short answer tests	Written test, with short questions on the theory of the subject. Evaluation of learning aims involving knowledge of legislation and how to perform measurements.	25	B2 B5	
Jobs and projects	Questions and report of the practical tasks. Evaluation of those learning aims related to noise measurement and analysis of acoustic problems using numerical calculations.	50	B5 B7	C76 C77

Other comments on the Evaluation

Following the guidelines of the degree, two systems of evaluation are offered: continuous assessment (recommended) and a final examination. Evaluation with only a final examination will be only allowed in situations in which it is imposible to follow the system recommended.

LANGUAGE: Any student can choose which language will use during the assessment process (English, Spanish).

CONTINUOUS ASSESSMENT:

In order to be qualiffied following the continuous assessment proccess, the student will have to assist at least to the 80% of the programmed activities. The continuous assessment will be based in the evaluation of practical task, projects and two tests. Once a student has signed a document of agreement with the process of continuous assessment, the final degree will be obtained by the application of the criteria described bellow, even though a student could miss some of the tasks or tests envolved in the process.

Once the student has shown good skills in all the assesed learning aims (at least 4 over 10 points in each learning aim assesed), the final grade with be obtained from the weighted sum of the grade obtained in the following tasks with the weights given.

1. Reports/memories of practical exersices involving calculations with finite elements (FEM), that should be delivered around the week 11 (25% of the final grade).
2. Tutored works focused on the application of numerical methods to basic problems in acoustics. (50% of the final grade)
3. Short answer tests, around the week 9 (10 % of the final grade)
4. Individual test containing problems and practical exercises (15 % of the final note)

Tutored works are developed in groups. The final grade will be weighted taking into account the results of a cross assesment survey. To consider as "satiscactory" the contribution of each student to the group a minimum grade of 2 over 5 points is stablished.

The studenst have to show good skills in all the learning outcomes, therefore, four points over a ten points scale must be obtained in all the learning outcomes evaluated during the continuous evaluation process. The final grade will be obtaining through the addition of the grades obtained during the process with the weights given before. At least five over ten points should be obtained to pass the subject.
If it happens that the minimum requirement (4 over 10 points in all the learming outcomes) is not fullfilled and the weighted average is greater than 5 points, the final grade will be 4 over 10 points.

FINAL EXAMINATION (Continous Assesment)
The final examination consists in two tests (tasks 3 and 4 described before). Those students having less than four points in some of the practical tasks (1 and 2) should deliver those aditional jobs required by the teachers of the subjetc on the date of the final examination.

NON CONTINUOUS ASSESMENT:

A final examination is available for those students that for some reason could not follow the continuous evaluation assessment process. In this case there is date scheduled and officially published for final examination. The final examination will consist in two short answer tests, and some additional questions related with the practical tasks and projects.

The subject is assessed in a 0 to 10 points scale and it is considered "passed" if the final grade obtained if equal or greater than 5.

RETAKE:

There is scheduled date at the end of the semester for a final examination retake, for those students that either dropped out during the semester or failed. Prior the examination, a student can choose to follow the continuous assessment or the final examination. In the former selection, the grades obtained in the projects and practical tasks will be taken into account and the student will only answer to the short answer tests. If the later, (final examination), the student will have also to answer a full examination as described before.

Sources of information

Basic Bibliography

Ciskowski R.D. and Brebbia C.A., **Boundary Element Methods in Acoustics**,

CEN European Standards, **EN 12354-1:2000. Building Acoustics - Estimation of acoustic performance of buildings from the performance of elements - Part 1: Airborne sound insulation between rooms**,

Reddy, J.N., **An introduction to the Finite Element Method,**, 2ª y 3ª ed,

Complementary Bibliography

Johnson C., **Numerical solution of PDE by the finite element method.**,

Quarteroni A, Valli A., **Numerical approximation of partial differential equations**,

Juhl, P.M., **The Boundary Element Method for Sound Field Calculations**,

Recommendations

Subjects that it is recommended to have taken before

Mathematics: Linear algebra/V05G300V01104
Mathematics: Calculus 1/V05G300V01105
Mathematics: Calculus 2/V05G300V01203
Fundamentals of Sound and Image/V05G300V01405
Room Acoustics/V05G300V01635
Fundamentals of Acoustics Engineering/V05G300V01531