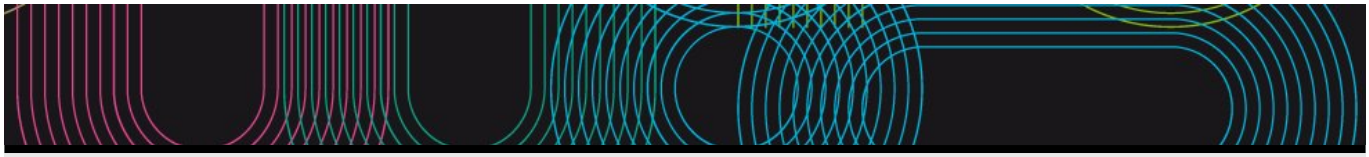

IDENTIFYING DATA				
Advanced acoustics				
Subject	Advanced acoustics			
Code	V05G301V01418			
Study programme	Grado en Ingeniería de Tecnologías de Telecomunicación			
Descriptors	ECTS Credits	Choose	Year	Quadmester
	6	Optional	4th	1st
Teaching language	English			
Department				
Coordinator	Sobreira Seoane, Manuel Ángel			
Lecturers	García Lomba, Guillermo Sobreira Seoane, Manuel Ángel			
E-mail	msobre@gts.uvigo.es			
Web	http://moovi.uvigo.gal			
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.			

Training and Learning Results	
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.
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.

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

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
Mentored work	12	30	42
Practices through ICT	12	24	36
Previous studies	0	15	15
Lecturing	19	38	57

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

Methodologies	
	Description
Mentored work	The student have develop two projects and deliver the corresponding reports for evaluation. 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.
Practices through ICT	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	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.
Lecturing	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 assistance	
Methodologies	**Description**
Lecturing	Lectures are developed within a continuous interaction framework, where students can answer questions delivered by the teacher. They could also solve their particular doubts during the sessions. In any case the students will be able to contact the teacher to request tutoring through the platform of the subject (moovi.uvigo.gal).
Mentored work	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.
Practices through ICT	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	
Mentored work	Two 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 assessed. Learning aims related to the identification of problems are also assessed (through the application of numerical calculations).	50	B2 B5 B7	C77
Practices through ICT	Realisation of 4 practices on simulation in acoustics using numerical methods: In three practices the Finite Element Method will be applied. The software COMSOL Multiphysics for the simulation of some specific cases in Acoustics will be used. The set of three practices will have a weight of 40% on the global grade. The remaining practice will solved using the with the package OpenBEM, that allows to apply the boundary elements method (BEM) to the analysis of the acoustic field in cavities (10% of the global note).	50	B2 B5 B7	C76 C77

Other comments on the Evaluation
Following the guidelines of the degree, students who take this subject will be offered two evaluation systems: continuous

and global assessment (at the end of the semester). By default it is assumed all students follow the continuous evaluation system unless they present a written resignation after the first month of class. The global evaluation system is only recommended in situations where it is impossible to follow the continuous evaluation process.

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

CONTINUOUS ASSESSMENT:

The continuous assessment will be carried out according to the methodologies and tests indicated below:

- Two supervised works (50% of the final grade). Each work weights a 25% on the final grade. The supervised works will be developed in groups.
    - The individual grade of each component of the group will be obtained through the results of cross-evaluation surveys among the members of the group and the individual presentation of the contribution to the work of the group. The minimum grade necessary to consider that the contribution of a student to the work of the group is satisfactory will be 2 out of 5 points.
    - The student's competences will be evaluated during the presentation of the work. Their capacities of synthesis, analysis, mastery of the specific vocabulary of the specialty and their skills for oral exchange will be taken into account. 25% of the final grade of the work will be assigned from the individual presentation.
- Delivery of three reports and results of practices with the support of ICT carried out with the finite element method (FEM) (40% of the final grade).
- Delivery of a practice report carried out with the boundary element method (BEM), on the acoustic field analysis in cavities. (10% of the final grade).

The final grade will be obtained through the weighted average of the grades obtained. A minimum of 4 out of 10 points in each work / practical report is required. In case a student does not meet the requirement in any of the competences evaluated but the weighted average is greater than 5, he will be assigned a failed as final grade (4.9 points). In this case, the student in continuous evaluation will have to do the tasks required to pass the final examination in the official data.
ORDINARY EXAM, GLOBAL ASSESSMENT:In case a student does not follow the continuous evaluation process, a final exam must be take on on the date published by the center. The student will have to:

- Deliver of two works requested by the teaching staff (1 work on the application of boundary elements, 1 work on the application of the finite element method). The student must obtain at least 4 out of 10 points in each of the works.
- Answer in a written exam questions about the theoretical contents of the subject. The student must obtain at least 4 out of 10 points.

The final grade will be obtained by averaging all the grades. In case the average grade exceeds 5 points but in either any of the works or in the written test the minimum requirement has not been met, the final grade will be fail (4.9 points).
EXTRAORDINARY AND END OF PROGRAM EXAMS: 1, GLOBAL ASSESSMENT:
Students who have to take a final extraordinary exam or an end or program exam must contact the teaching staff previously to request the assignment of two works, to proceed as described previously in case of the final exam in ordinary call.
2. CONTINUOUS ASSESSMENT:
In the case that a student following the continuous assessment proceess has passed he minimum requirements in some proof of evaluation (works/tests written) the grade will be kept during 1 academic year. Either a written test or some works agreed with the teacher mus be done. The grades will not be kept if they have been obtained in past academic years.

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