



Teaching Guide

Identifying Data					2018/19
Subject (*)	Boundary element methods		Code	614855230	
Study programme	Mestrado Universitario en Matemática Industrial (2013)				
Descriptors					
Cycle	Period	Year	Type	Credits	
Official Master's Degree	2nd four-month period	First	Optional	3	
Language	Spanish				
Teaching method	Face-to-face				
Prerequisites					
Department	Matemáticas				
Coordinador	Gonzalez Taboada, Maria	E-mail	maria.gonzalez.taboada@udc.es		
Lecturers	Gonzalez Taboada, Maria	E-mail	maria.gonzalez.taboada@udc.es		
Web	http://www.m2i.es				
General description	We provide an introduction to boundary element methods. Using as a model a potential problem, we present the direct method and the indirect methods based on single layer and double layer formulations to solve both interior and exterior problems in two and three dimensions. We also discuss the application of boundary element methods to acoustic scattering and radiation problems.				

Study programme competences / results

Code	Study programme competences / results
A4	Ser capaz de seleccionar un conjunto de técnicas numéricas, lenguajes y herramientas informáticas, adecuadas para resolver un modelo matemático.
A5	Ser capaz de validar e interpretar los resultados obtenidos, comparando con visualizaciones, medidas experimentales y/o requisitos funcionales del correspondiente sistema físico/de ingeniería.
A8	Saber adaptar, modificar e implementar herramientas de software de simulación numérica.
A9	Conocer, saber seleccionar y saber manejar las herramientas de software profesional (tanto comercial como libre) más adecuadas para la simulación de procesos en el sector industrial y empresarial.
B1	Saber aplicar los conocimientos adquiridos y su capacidad de resolución de problemas en entornos nuevos o poco conocidos dentro de contextos más amplios, incluyendo la capacidad de integrarse en equipos multidisciplinares de I+D+i en el entorno empresarial.
B4	Saber comunicar las conclusiones, junto con los conocimientos y razones últimas que las sustentan, a públicos especializados y no especializados de un modo claro y sin ambigüedades.
B5	Poseer las habilidades de aprendizaje que les permitan continuar estudiando de un modo que habrá de ser en gran medida autodirigido o autónomo, y poder emprender con éxito estudios de doctorado.

Learning outcomes

Learning outcomes	Study programme competences / results		
To know the steps to solve a boundary value problem using the boundary element method	AC4	BJ1 BC3	
To know the advantages and limitations of the boundary element method	AC4	BJ1	
To know the fundamental solutions, the integral representation formula and the boundary integral equations related to the problems considered in this subject	AC4	BJ1 BC3	
To know and be able to apply the direct and indirect methods	AC4	BJ1 BC3	
Given a boundary integral equation, be able to discretize it using the boundary element method and to derive the associated linear system		BJ1 BC3	



Be able to construct Matlab programs that solve an elliptic problem using the boundary element method.	AC4	BJ1
	AC5	BC3
	AC8	BR1
	AC9	

Contents	
Topic	Sub-topic
Introduction to the boundary element method. Potential problems.	<ul style="list-style-type: none"> - Interior and exterior problems for the Laplace equation. - Fundamental solution for the Laplace operator. - Representation formulae of an harmonic function. - Integral equations on the boundary. - Direct and indirect methods. Analysis of the variational formulations. - Discretization. A priori error estimates. - Some practical considerations on the numerical solution of the discrete problem.
Boundary element methods in acoustics.	<ul style="list-style-type: none"> - The wave equation and the Helmholtz equation. - Acoustic scattering and radiation problems in harmonic regime. - Fundamental solutions of the Helmholtz operator. - Green's representation formulae. Single and double layer potentials. - Boundary integral equations. - Direct and indirect methods. - Discretization of the equations. - Implementation.
Introducción ol acoplamento de elementos finitos e elementos de contorno	
Introduction to the coupling of boundary elements and finite elements	

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A4 B5 B1 B4	14	35	49
Laboratory practice	A5 A9 A8	7	7	14
Supervised projects	A4 A5 A8 B5 B1 B4	1	9	10
Personalized attention		2	0	2

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

Methodologies	
Methodologies	Description
Guest lecture / keynote speech	The theoretical contents will be presented through lectures.
Laboratory practice	The implementation in Matlab of the boundary element method to solve the problems considered in the subject will be shown.
Supervised projects	At the end of the course, a project will be proposed to each student.

Personalized attention	
Methodologies	Description
Supervised projects	Students can ask to the teacher any questions that arise during the performance of the project that has been proposed to them.



Assessment

Methodologies	Competencies / Results	Description	Qualification
Supervised projects	A4 A5 A8 B5 B1 B4	The evaluation of the knowledge acquired in this subject will take into account the completion of the exercises presented in the lectures (50% of the final grade) and the supervised work that will be proposed at the end of the subject (50% remaining).	100

Assessment comments

Sources of information	
Basic	<ul style="list-style-type: none"> - K.-C. Ang (2007). Introducing the boundary element method with MATLAB. Int. J. Math. Education in Sci. and Technology - G. Chen y J. Zhou (1992). Boundary Element Methods. Academic Press - S.A. Sauter y C. Schwab (2011). Boundary Element Methods. Springer
Complementary	<ul style="list-style-type: none"> - R. Adams (1979). Sobolev spaces. Academic Press - G. Beer (2001). Programming the Boundary Element Method. John Wiley & Sons - C.A. Brebbia y J. Dominguez (1992). Boundary Elements. An introductory course.. McGraw-Hill - W. Hackbusch (1995). Integral Equations. Birkhauser - R. Kress (2014). Linear integral equations. Springer - W. McLean (2000). Strongly elliptic systems and boundary integral equations. Cambridge University Press

Recommendations

Subjects that it is recommended to have taken before

Numerical methods and programming/614855201

Numerical methods for partial differential equations/614855204

Subjects that are recommended to be taken simultaneously

Acoustics/614855209

Subjects that continue the syllabus

Other comments

It is recommended that students take the subject up to date and use the tutorial hours to resolve their doubts.

(*)The teaching guide is the document in which the URV publishes the information about all its courses. It is a public document and cannot be modified. Only in exceptional cases can it be revised by the competent agent or duly revised so that it is in line with current legislation.