 UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				**2020/21**
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	Hybrid			
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.			
Contingency plan	1. Modifications to the contents There will be no changes. 2. Methodologies *Teaching methodologies that are maintained All. *Teaching methodologies that are modified None. 3. Mechanisms for personalized attention to students E-mail: The teacher will check it every day in order to solve quick questions, fix virtual meetings to solve students doubts and to follow the development of the supervised projects. Teams: There will be two weekly sessions to advance in the contents and supervised projects. These sessions will take place within the assigned timetable. 4. Modifications in the evaluation None. *Evaluation observations: 5. Modifications to the bibliography or webgraphy None. The working materials will be given to students through e-mail or via Moodle.			

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.
A8	Saber adaptar, modificar e implementar herramientas de software de simulación numérica.
B3	Ser capaz de integrar conocimientos para enfrentarse a la formulación de juicios a partir de información que, aun siendo incompleta o limitada, incluya reflexiones sobre las responsabilidades sociales y éticas vinculadas a la aplicación de sus conocimientos.
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 advantages and limitations of the boundary element method	AC4	BC2 BR1
To know the steps to solve a boundary value problem using the boundary element method		BC2 BR1
To know the fundamental solutions, the integral representation formula and the boundary integral equations related to the problems considered in this subject	AC4	BC2 BR1
Be able to construct Matlab programs that solve an elliptic problem using the boundary element method.	AC8	BC2 BR1
To know and be able to apply the direct and indirect methods	AC4	BC2 BR1
Given a boundary integral equation, be able to discretize it using the boundary element method and to derive the associated linear system	AC8	BC2 BR1

Contents	
Topic	**Sub-topic**
Introduction to the boundary element method. Potential problems.	1. Interior and exterior problems for the Laplace equation. 2. Fundamental solution for the Laplace operator. 3. Representation formulae of an harmonic function. 4. Integral equations on the boundary. 5. Direct and indirect methods. Analysis of the variational formulations. 6. Discretization. A priori error estimates. 7. Some practical considerations on the numerical solution of the discrete problem.
Other applications of the boundary element methods.	1. The boundary element method in acoustics. Acoustic scattering problems and radiation problems in harmonic regime. 2. The boundary element method for the Stokes problem. 3. The boundary element method in elastostatics.
Introduction to the coupling of boundary elements and finite elements	1. The method of Johnson and Nédelec. 2. The symmetric method of Costabel and Han.

Planning				
Methodologies / tests	**Competencies / Results**	**Teaching hours (in-person & virtual)**	**Student?s personal work hours**	**Total hours**
Guest lecture / keynote speech	A4 B5 B3	14	35	49
Laboratory practice	A8 B5 B3	7	7	14
Supervised projects	A4 A8 B5 B3	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 A8 B5 B3	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
The evaluation criteria are the same in June and July.

Sources of information	
Basic	- 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	- R. Adams (1979). Sobolev spaces. Academic Press - G. Beer (2001). Programming the Boundary Element Method. John Wiley &amp; Sons - C.A. Brebbia y J. Dominguez (1992). Boundary Elements. An introductory course.. McGraw-Hill - W. Hackbusch (1995). Integral Equations. Birkhauser - W. McLean (2000). Strongly elliptic systems and boundary integral equations. Cambridge University Press - R. Kress (2014). Linear integral equations. Springer

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
Subjects that continue the syllabus
Other comments
It is recommended that students take the subject up to date and use the tutorial hours to solve their doubts.