UNIVERSIDADE DA CORUÑA

Teaching Guide				
Identifying Data				2021/22
Subject (*)	Numerical methods and programming		Code	614855201
Study programme	Mestrado Universitario en Matemática Industrial (2013)			
Descriptors				
Cycle	Period	Year	Type	Credits
Official Master's Degree	1st four-month period	First	Obligatory	6
Language	Spanish			
Teaching method	Face-to-face			
Prerequisites				
Department	Departamento profesorado másterMatemáticas			
Coordinador	Pena Brage, Francisco José	E-mail		
Lecturers	García Rodríguez, José Antonio Pena Brage, Francisco José Santamarina Ríos, Duarte	E-mail	jose.garcia.rodriguez@udc.es	
Web	www.m2i.es/docs/modulos/FBasica/4.Metodos%20Numericos%20y%20Programacion.pdf			
General description	In this subject, elementary numerical methods are presented to solve systems of linear and nonlinear equations, and to approximate functions, their derivatives and integrals.			

Contingency plan	The situation of this interuniversity Master is unique since, by involving several universities, for years it has been designed in mixed mode: videoconferencing systems are used, all classes are recorded and stored for asynchronous consultations, telematic platforms are used for delivery and evaluation of works, projects, etc. 1. Modifications in the contents. There will be no content modification. 2. Methodologies * Teaching methodologies that are maintained This Master is interuniversity and uses videoconferencing systems from the beginning. Therefore, the methodologies are maintained in any scenario, when using the M2I Master Video Conferencing System for Teaching * Teaching methodologies that change All classes go 100% to videoconferencing mode, instead of using a mixed system. 3. Mechanisms for personalized attention to students. Personalized attention was always carried out in a mixed way: in person and by videoconference. Therefore it will be moved 100% to OnLine: email and Teams. 4. Modifications in the evaluation. The evaluation system is maintained. Videoconferencing systems will be used. as it has been doing for years, since the creation of the master. * Evaluation observations: 5. Modifications to the bibliography or webography. No modifications to the bibliography necessary

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.
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		
1. To know the elementary numerical methods for solving systems of linear and nonlinear equations, and to aproximate a function, its derivatives and its definite integral.	AC4 AC8	BJ1 BR1	
2. Be able to effitiently use the calculus package MatLab for solving the problems studied in this subject.	AC4 AC8	BJ1 BR1	
3. Have a good predisposition for solving problems.	AC4 AC8	BJ1 BC3 BR1	
4. Be able to evaluate the difficulties involved in the process of solving a given problem, and taking them into account, be able to choose the more appropriate numerical method for solving it (among the studied ones).	AC4 AC8	BJ1 BR1	
5. Be able to look up in the bibliography, to read and to understand the necessary information for solving a given problem.	AC4 AC8	BJ1 BR1	

Contents	
Topic	Sub-topic
Introduction to programming	1. Introduction to matlab. Commands and basic functions. 2. Vectors and matrices in Matlab. Sparse matrices. Graphical representation. 3. Files .m and programming. Data structures in Matlab. 4. Introduction to Fortran 90: data types and flow control. 5. ?Arrays? in Fortran 90. Proceedings, modules and interfaces. 6. Input/output of data in Fortran 90.
Numerical methods	7. Numerical solution of linear systems: Conditioning of a system of linear equations. Direct methods: LU, LL^t, LDL^t y QR. Classical iterative methods: Jacobi, Gauss--Seidel, SOR and SSOR. Convergence tests. Numerical methods for the calculus of eigenvalues and eigenvectors. 8. Numerical solution of systems of nonlinear equations: review of numerical methods for solving nonlinear equations. Fixed point iteration method. Newton method. Computationanl comments. 9. Interpolation. Lagrange interpolation. Hermite interpolation. Runge effect. Approximation using splines. 10. Numerical differentiation and integration. Numerical derivatives of polynomial interpolation type. Numerical integration in one variable. Formulas of Newton-Cotes. Gauss formulas. Compound formulas. 11. Interpolation and numerical integration in several variables.

Planning				
Methodologies / tests	Competencies / Results	Teaching hours (in-person & virtual)	Student?s personal work hours	Total hours
Guest lecture / keynote speech	A4 A8 B5 B1	20	40	60
Laboratory practice	A4 A8 B5 B1	20	40	60
Supervised projects	A4 B5 B1 B4	0	20	20
Objective test	A4 B5 B1	4	0	4
Personalized attention		6	0	6

(*)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	In the theoretical sessions the teacher will present the theoretical contents of the subject, using illustrative examples for motivating the students and helping the comprenssion and assimilation of the contents. The teacher will use dynamic presentations that the students will be able to download on beforehanddende from the virtual site of the subject in Moodle (And, if necessary, the data will be sent by e-mail).
Laboratory practice	During the course, several pactical assignments will be proposed to the students. The students must implement in Matlab some of the numerical methods studied in this subject, validate their programs and prepare a report describing the developed codes. Also practical problems will be propposed using the numerical methods studied in the subject. All this practices will be taken into account for thre final evaluation.
Supervised projects	Os alumnos deberán resolver exercicios teóricos relacionados coas técnicas que se estuden nas horas de docencia expositiva
Objective test	This is the final exam of the subject, and it has two parts. In the first part, several theoretical exercises will be proposed relating, for example, the range of application of the studied methods and their convergence properties. In the second part, the students will solve a practical case using the studied commands and the programs developed in Matlab or, if this is the case, implementing the necessary algorithms.

Personalized attention	
Methodologies	**Description**
Laboratory practice	Students will be able to ask the teachers of the subject any doubt arising during problems solving and also during the implementation of the laboratory practices.

Assessment			
Methodologies	**Competencies / Results**	**Description**	**Qualification**
Laboratory practice	A4 A8 B5 B1	The hability of student to solve the problems studied in the subject using the calculus package MatLab is evaluated, as well as, and their skills to efficiently implement the studied numerical methods. We also evaluate the kwnoledge of the students to apply the studied theoretical results.	50
Objective test	A4 B5 B1	The theoretical and practical knowledges learnt by the student are evaluated.	50

Assessment comments

CRITERIA FOR THE 1ST ASSESSMENT OPPORTUNITY

The first part (50% of the qualification) will consist on the evaluation of the Matlab and Fortran practical works; both works will have the same weight to calculate the qualification of this part.

The second part (the remaining 50%) will correspond to the exam, where the concepts acquired in the part II of the subject will be evaluated.

Students must pass both parts in order to pass the subject. If one of the parts is not passed the qualification will be 4 out of 10.

A student will be considered as ?presented? when the exam and/or two practical works are presented.

CRITERIA FOR THE 2ND ASSESSMENT OPPORTUNITY

The same as for the first opportunity. The deadline for handing in the tasks will be adapted to the date of the second exam

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Sources of information	
Basic	- Quarteroni, A. y Saleri, F. (2006). Cálculo Científico con MATLAB y Octave. Springer - Kincaid, D. y Cheney, W. (1994). Análisis numérico. Las matemáticas del cálculo científico. Addison Wesley Iberoamericana - Epperson, J.F. (2007). An introduction to numerical methods and analysis. John Wiley & Sons - T. Aranda, J.G. García (1999). Notas sobre Matlab. Universidad de Oviedo, Servicio de Publicaciones - J.A. Infante del Río, J.M. Rey Cabezas (2007). Métodos numéricos. Pirámide Os libros de Infante del Río e Quarteroni y Saleri son os que se siguen para a mayor parte dos contenidos.
Complementary	- Golub, G.H. y van Loan, C.F. (1996). Matrix Computations. John Hopkins, University Press - Kelley, C.T. (2003). Solving Nonlinear Equations with Newton?s Method. SIAM - Kiusalaas, J. (2005). Numerical Methods in Engineering with MATLAB. Cambridge University Press - Viaño, J.M. y Burguera, M. (1999). Lecciones de métodos numéricos. 3.- Interpolación. Tórculo Edicións - Viaño, J.M. (1997). Lecciones de métodos numéricos. 2.- Resolución de ecuaciones numéricas. Tórculo Edicións - .D. Faires, R. Burden. (2011). Análisis Numérico. Thomson - P.G. Ciarlet (1989). Introduction to numerical linear algebra and optimisation.. Cambridge University Press - M. Metcalf, J.K. Reid (2011). Modern Fortran Explained. Oxford University Press

Recommendations
Subjects that it is recommended to have taken before
Elementos Finitos I/614455102 Diferenzas Finitas/614455205 Elementos de Contorno/614455207 Elementos Finitos II/614455208 Métodos Numéricos en Optimización/614455210 Métodos Numéricos II/614455211 Métodos Numéricos para Ecuacións Diferenciais Ordinarias (EDO)/614455212 Cálculo Paralelo/614455202
Subjects that are recommended to be taken simultaneously
Linguaxes e Contornos de Programación I/614455104
Subjects that continue the syllabus
Other comments
To be able toi understand the methods presented in this subject it is necessary to have elemental knowledge of linear algebra and diferential and integral calculus. It is also recomended to study the contents developed in the subject at the time they are introduced, making the assigments and the proposed practices, and making use of the thutories and consulting recommended bibliography.

(*)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.